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Landtype Associations Of Blue Mountains Ecoregion

Malheur - Umatilla - Wallowa Whitman - portions of Ochoco National Forests

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Landtype Associations Of Blue Mountains Ecoregion In Oregon and Washington

(Malheur, Umatilla, Wallowa-Whitman and a portion of the Ochoco National Forests)

Written by:
Joni Sasich, CPSS

Based upon the work
by
Robert J. Ottersberg
CORDILLERAN SERVICES INC
LaGrande, OR

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AUTHOR CONTACT INFORMATION:

RESOURCES
15304 W. Jacobs Rd
Spokane, WA 99224
ph 509-244-9946

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This final report is only a small reflection of the enormous contribution that Bob Ottersberg has made to our understanding of the ecological relationships in the Blue Mountains Ecoregion. Bob dedicated his professional life, living, breathing, and teaching soil-ecological relationships to whoever would listen. For a quiet and gentle human being, Bob left an impact that will be felt for a long while. He is sorely missed by those who felt his influence. The LTA project is just one of his legacies along with classifying hundreds of new soils and mapping their distribution across the landscape as the project leader for the Terrestrial Ecological Unit Inventory of Landtypes in the Malheur, Umatilla and Wallowa-Whitman National Forests. As Bob was not able to bring this project to final completion, it has been the author's privilege to help to do so.

Foreward

Landtype Associations (LTAs) of the Blue Mountain Ecoregion is an ecological inventory that identifies similar physical and biological processes across the landscape. Information from this inventory can be used to interpret landscapes for many different management purposes. LTAs integrate three major landscape features to interpret ecological processes. Features forming the basis for LTAs are landform expression, geology representing similar regolith and bedrock features, and potential natural vegetation used to identify climatic environments.

The inventory comprises about 5.9 million acres covering the Snow Mountain Area of the Ochoco National Forest, and the Malheur, Umatilla, Wallowa-Whitman National Forests. The initial map coverage and identification legend was developed by Robert J. Ottersberg in 2002. Technical review, final correlation, some additional mapping, and completion of documentation have led to this final report in 2006.

Landtype Associations of Blue Mountain Ecoregion is based upon the National Hierarchical Framework of Ecological Units (USDA 1993) and was guided by the Terrestrial Ecological Unit Inventory Technical Guide: Landscape and Land Unit Scales (Winthers and others 2005). The hierarchical framework and protocols provide a consistent approach to ecological land unit identification that can be aggregated for regional or national scale analysis or can be further subdivided for forest or project-level analysis.

This survey has been conducted at the Landscape level with a primary purpose of identifying concepts useful in forest-level resource planning. The appropriate scale for map display is 1:100,000. The focus of this survey is to identify significant differences in the landscape and to aggregate landscape elements with similarities of interpretative significance. At a larger scale aggregated elements may become mapping differentia and be separated for more detailed analysis, such as project-level planning.

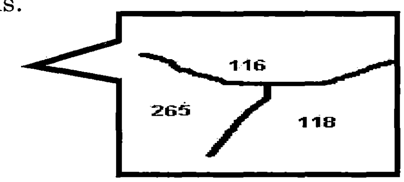
Other uses for this inventory are: 1) to stratify or help focus monitoring programs; 2) identify areas of general limitations or attributes that may help direct project planning; 3) identify areas of similarities that could serve in developing area-wide management strategies such as for road maintenance or wildlife habitat management areas, and 4) used in synthesis of multiple ecological processes within a given area such as hydrologic response, wildfire patterns, or wildlife movement to understand or predict a certain response to disturbances.

The grouping of landscape features in itself provides a useful means for interpreting ecological processes, temporally and spatially. The user is encouraged to learn and understand how the survey was developed and why certain mapping differentia or landscape features were grouped, as this will enhance their understanding of each Landtype Association. A discussion of survey methods can be found in Part I. The interpretation tables in Part IV provide a comparison of general properties of landscape features and interpretation ratings for the more common, present-day management applications. A detailed explanation of how general properties and ratings where derived and how they should be interpreted are included in this section. It is essential that users understand the basis for these interpretations prior to using in any analysis. Users should also know that at the landscape level, a property or response rating may not be expressed everywhere within a single polygon of a Landtype Association. Many of the Landtype Associations are mosaics of different ecological types. The more one understands what feature is linked with the property or rating, the higher utility this tool will serve the user.

How to Use This Report and Maps

Step One: Review the introductory pages in the report. Become familiar with the kind of interpretations that are available from the Landtype Association (LTA) inventory. Review how the inventory was designed. As with any map resource, it is important to understand the appropriate scale to apply this information and the relative limits of the interpretations as a result of scale. This step will help in planning an effective analysis.

Step Two: Identify LTAs within your area of interest.



Step Three: Make a list of the LTAs within your area of interest. Turn to Part III, Table 6 -Landtype Association Identification Legend for a description of the landform group, geology group, and potential natural vegetation zone for the LTAs on your list.

Part III Landtype Association Identification Legend

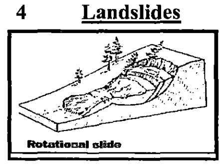
Landtype Associations Identification Legend – Blue Mountains coregion				
Map Symbol	**Vegetation Zones** (PNV)	**Bedrock Geology**	**Landform**	**Total Area**
115	Moist Forest	Basic Igneous Rocks	Basins, Fans, & Terraces	
116	Moist Forest	Basic Igneous Rocks	Mountain Slopes, Gentle	
117	Moist Forest	Basic Igneous Rocks	Mountain Slopes, Steep	
118	Moist Forest	Basic Igneous Rocks	Canyons	
124	Moist Forest	Clay Producing Materials	Landslide	
125	Moist Forest	Clay Producing Materials	Basins, Fans, &	

Forest resource professionals will begin to visualize the setting of each Landtype Association; relating to their past observations. Overlaying other data layers, such as streams and topographic contour elevations may further enhance the users' visualization of Landtype Association settings.

Step Four: For a more detailed description of each LTA component, turn to Part II for descriptions of landform groups, geology groups, and potential natural vegetation zones. Be sure to note that for some LTAs, more than one geology group or potential natural vegetation groups may be listed for a LTA.

Part II Landtype Association Map Unit Components

4 **Landslides**



This landform occurs on deep large-scale landslide deposits. It consists of a series of benches intermixed with hummocky irregular mounds and depressions. The landform is shaped,

Step Five: Turn to Part IV, Landtype Association Management Applications in the Report to obtain interpretations that are of interest to your analysis. Each kind of interpretation and its relative rating or descriptor is defined in the narrative preceding the table.

Step Six: Maps displaying interpretations may be constructed at this point. For example, a map display could be constructed of all Landtype Associations with potential habitat for lynx or mule deer or a map could be constructed displaying areas with flashy hydrology or a map that displays areas requiring a higher level of monitoring for erosion after wildfire.

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PART I:
Landtype Association Survey Principles and Methods

Introduction

The Washington Office of the Forest Service provided national direction for ecological surveys in the *National Hierarchical Framework of Ecological Units* (USDA Forest Service 1993) and in the *Terrestrial Ecological Unit Inventory Technical Guide: Landscape and Land Unit Scales* (Winthers and others 2005). This direction established a consistent approach to ecosystem mapping and analysis by providing a mapping and classification system that stratifies the earth into "progressively smaller areas of increasingly uniform ecological potential" (USDA Forest Service 1993). An overall picture of the hierarchical framework is displayed in Table 1. This approach was developed from earlier regional "landsystems" mapping approaches that stratified the landscape by integrating several terrestrial features to display multi-resource attributes of the landscape (Wertz 1972 and USDA Forest Service 1976).

Table 1. National Hierarchical Framework of Ecological Units

Analysis Scale Ecological Unit	Map Unit Criteria	Map Scale	General Use
Ecoregions:			
Domain	• Broad climatic zones	1,000,000's to 10,000's of square miles	National and international planning, modeling, and assessments
Division	• Regional climatic types • Potential Natural Vegetation (PNV) formations • Soil Orders		
Province	• PNV formations or series • Mountains with complex vertical zonation		
Subregions:			
Section	• Geomorphology, stratigraphy, surficial geology, lithology • Climatic data • Soil Orders, Suborders, and Great Groups • PNV series	1,000's to 10's of square miles	Regional planning including multi-forest, statewide, and multi-agency analysis and assessments
Subsection			
Landscape:			
Landtype Association	• Geomorphic processes, geologic formation, surficial geology. • Local climate • Soil Subgroups, Families or Series • PNV series, Sub-Series, or Plant Associations	1,000's to 100's of acres	Forest or area-wide planning and watershed analysis
Land Unit:			
Landtype	• Landform and slope position • Elevation, aspect, and slope • Soil Subgroups, Families, or Series • PNV Plant Associations or Phases	100's to less than 10 acres	Project and management area planning and analysis
Landtype Phase			

Level IV Ecoregions (analogous to subsections) of the Blue Mountains were previously delineated and described by Clarke and Bryce (1997) in *Hierarchical Subdivisions of the Columbia Plateau and Blue Mountains Ecoregions, Oregon and Washington.* This work stratified seven contiguous basins in the Blue Mountains using broad groups of geology, landform, and potential natural vegetation. Level IV Ecoregions provide a framework for use at regional and national scales and a basis for further stratification at lower levels in the hierarchical framework.

This product, Landtype Associations of the Blue Mountains Ecoregion was constructed within the hierarchical framework using the landscape scale to serve Forest-level analysis, such as, for Forest Plans, watershed or landscape analysis, monitoring programs, and initial project planning. Comparing landscape scale and ecoregion scale in Table 1, there are similarities in map unit criteria but differences in the scale and intensity in mapping landscape features. Differences are driven by the requirement for a different level of use.

To develop a sense of what interpretations would be of most use from Landtype Associations for the Blue Mountain National Forests, an interdisciplinary team of forest planners, ecologists, soil scientists, silviculturists, wildlife biologists, hydrologists, and fisheries biologists were consulted and assisted in directing elements of the survey. One of the highest priorities was to provide a product that could be used for Forest Plan revision. Many of the expected planning issues relate to wildlife habitat, soil productivity, suitability for timber and range management, hydrologic and soil properties and their response to management activities and natural disturbance.

Another objective for the Landtype Associations of the Blue Mountain Ecoregion was to allow for logical grouping or aggregation upward in the hierarchical framework to the Subsection Level and to provide a basis for further division to the Land Unit level for continuity within the Terrestrial Ecological Unit hierarchical framework.

Landtype Association Survey Design

This section discusses the elements involved in designing Landscape Associations of the Blue Mountains. These elements include: 1) identification of survey objectives or, "what are the questions the survey needs to address", 2) definition of mapping criteria that that address survey objective questions, and 3) identification of mappable features or mapping differentia that provide focus for consistent delineation of map units.

Survey objectives were defined by the Forest Plan revision needs and other landscape analysis needs identified by an interdisciplinary team as discussed in the previous section.

Guided by discussions and ecological unit concepts in Clarke and Bryce (1997) and others before them (Swanson 1979, Bailey 1996, Wertz 1972), mapping criteria were selected based upon their capability to identify geomorphic and biological processes affecting today's landscapes. Important processes were those directly or indirectly linked to hydrologic regime, sedimentation regime including mass wasting and soil erosion, soil regolith properties and distribution, productivity influencing plant growth and habitat

characteristics, and stream channel processes important to aquatic habitat. Thus, all of the map criteria listed for landscape scale in Table 1 were deemed important to identify. Local, regional, or national classification systems were used whenever possible to provide consistency in identification of mapping criteria elements. Grouping of these elements was done based upon the limits of map scale and similarities of processes defined by each classification systems.

Geomorphic Expression or Landform

Geomorphic expression or landform is an excellent identifier of ecological units because it is the topographic expression of the sum of geomorphic processes as they are influenced by climate, time, geology, and other landscape factors. Although historic processes may or may not be present today, landform genesis have shaped the topography, soil regolith, and stream patterns that continue to influence present day processes.

Geomorphic processes of interest to landscape-scale analysis are sedimentation and hydrologic processes, specifically, mass wasting, surface erosion, runoff, channel processes, and subsurface water movement and storage. All of these processes shape landform expression and can be interpreted in the context of rate and frequency, and time, i.e., relic, dormant, or active. Slope gradient, density and character of dissection, and slope shape are all individually important to geomorphic process and can be described uniquely for each landform. Only when the array of these landscape elements are integrated into a landform expression does one recognize the power of using landform as key mapping criteria for interpreting ecological processes. For example, slope gradients greater than 60% are commonly recognized for high erosion hazard but may or may not have a high mass wasting hazard or high sedimentation hazard. Slopes with greater than 60% and a concave slope shape have a much higher mass-wasting hazard than those with convex shapes. Sediment delivery potential of these two landforms varies depending on density of stream channels in the landform and complexity of slope shape. Less complex slopes and greater extent of concave shape has higher delivery efficiency than more complex slopes with greater extent of convex shape with variation in slope steepness.

Relationships between landform and channel geomorphic process have also been observed (Strahler 1964). More recently, stream classification systems have been developed using channel geomorphology to interpret channel processes important to aquatic habitat (Rosgen 1994, Montgomery and Buffington 1993).

Geomorphic expression tends to be readily mapped, because of their repeatable characteristics given similar settings, creating landscape patterns and features easily identified on topographic maps and/or aerial photographs. This consistency can increase the level of confidence in the mapping and allows for extrapolation from one area to another with similar expression. Landform expression is influenced by geology and comparisons can be made using a landform element on different geologic types. Interpretation of resistance to erosion or slope stability can be made for different geologic types using geomorphic expression. An understanding of landform genesis along with climate provides and insight into soil distribution and occurrence. Synthesis of topographic and geomorphic features with soil distribution can increase capability in predicting variations of runoff dynamics, flow duration and amount, subsurface flow and

storage, relative turbidity, sediment delivery efficiency, channel morphology, mass wasting, and surface erosion across the landscape.

Landforms were categorized for Landtype Associations based upon ability to recognize features consistently at a map scale of 1:100,000 and for important active processes associated with them that are unique when compared to processes associated with other landforms. *A Geomorphic Classification System* by (Haskins and others 1996) was used to guide landform classification and nomenclature and to provide structure to examining geomorphic processes. In the end, some of nomenclature was modified to meet the needs of the mapping scale and for interpretative uses.

Geology

Geologic characteristics were identified as important mapping criteria because they influence rates of geomorphic processes over the course of landform development. As described previously, geology as a mapping criterion serves to further refine the interpretative value of the first mapping criteria, geomorphic process. Geology has a strong controlling influence on landform development, soil formation, and hydrologic response (Bailey 1996). Some diagnostic site features influenced by geology are drainage patterns, soil regolith properties, topography, and channel substrates. Weathering resistance, stability, bedrock exposure, stratigraphy, and other characteristics of different geology formations either directly or indirectly influence the rate of a geomorphic process; such as mass wasting, subsurface water recharge and storage, or surface runoff.

Geologic formations, both bedrock and surficial deposits, are map features useful as an LTA mapping criterion. Formations were grouped based upon similarities in their influence on rate of geomorphic processes and on soil regolith properties.

Potential Natural Vegetation (PNV)

Vegetation expression is an indicator of today's climate and to some degree disturbance regime. The choice to use potential natural vegetation over current vegetation is that current vegetation is ever changing, responding to both natural and management related disturbance and does not serve as a good baseline.

Potential Natural Vegetation (PNV) is based upon a plant association classification system established by the hypothesis that communities have identifiable successional sequences and that certain communities of plants are indicative of that specific and unique successional sequence. A community or plant association is named for a unique suite of plants. Plant associations are strongly dependent on climate, and other landscape factors such as soil properties that further influence climatic effects on vegetation.. Thus, potential natural vegetation becomes a reliable indicator of different climatic regimes and soil properties across the landscape. Using PNV as a mapping criterion allows for interpretation for vegetation dynamics spatially and over time which is useful in wildlife habitat interpretation, in timber management, and in predictions of vegetation response to disturbance.

Plant Associations used to classify PNV were defined in *Plant Associations of the Blue and Ochoco Mountains* (Johnson, C. and Clausnitzer, R. 1992). Plant Associations were grouped for use at the Landtype Association scale based upon common soil climatic themes such as limit or not limiting soil moisture and soil temperature regimes. These groups are called Vegetation Zones.

Soils

Soils were not identified as a mapping criterion but are an important map unit component. Numerous management interpretations in this survey are based upon soils characteristics, e.g., regolith texture and depth, soil climate, and parent material. Representative soil series for each LTA were identified using existing and draft soil survey information where available. Some series were extrapolated to other areas without soil survey information using association with certain landform, vegetation, and parent material. Where extrapolation could not be done reliably, soil series are noted as "undetermined". Sources used were the Terrestrial Ecological Unit Inventory (USDA Forest Service in progress), Baker County Soil Survey (USDA Natural Resource Conservation Service 1997, the Soil Resource Inventory – Malheur National Forest (USDA Forest Service 1974), and the Soil Resource Inventory – Ochoco National Forest (USDA Forest Service 1977).

Soil series, listed with each LTA map unit, were chosen to represent major kinds of soil and soil properties. Other soils of lesser extent or soils with similar characteristics may occur but were combined under a representative soil series. For more detailed soils information, users should consult their local soil survey. Some series taken from the "in progress" Terrestrial Ecological Unit Inventory are tentative or provisional and may change as inventory is completed. For continuity, all representative soils are listed with their taxonomic name classified to the family level. The taxonomic name is useful as it often indicates temperature and moisture regime, unique surface layers, and regolith textures.

Silt-size volcanic ash deposited across the landscape from the eruption of Mount Mazama about 7,700 years ago strongly influence biological and physical properties of soils in the Blue Mountain Ecoregion. Initial ash mantle deposition was likely not uniform and was redistributed and mixed with other materials by wind and water. The distribution, depth, and purity of ash in soil surface layers provide insight to past and present ecological processes. Dunes of ash and loess occur on plateaus exposed to strong winds; the size and orientation often represent the landform's exposure to dominant wind direction. Thick deposits are found on gently sloping, leeward positions, north and east aspect backslopes and footslopes, in basins, and on remnant alluvial terraces; all indicating areas of deposition of ash from redistributed by erosion. Often these areas also have relatively pure ash indicating a stable erosional environment. Mixed ash occurs on colluvial foot slopes, climatic zones with more frequent fire and areas that receive significant loess deposition. These areas indicate a less stable, more erosional environment either from slope steepness, less vegetation cover, or episodes of vegetation removal. Minor amounts of ash remain on steep mountain slopes, areas with frequent fire and wind-swept benches indicating an active erosional environment. Soil materials in flood plains and low terraces on valley floors are devoid of ash, having been washed away in swift runoff. This is in

contrast with perched stream terraces above the current stream base level that may have thick deposits of relatively unweathered ash representing a catastrophic erosional event soon after the eruption. These predictable patterns of ash serve as an index to past landscape stability and disturbance regimes and they directly influence today's processes.

Ash mantle depth and purity affects vegetation type, productivity, and erosion and runoff processes. Weathered volcanic ash tends to hold additional soil moisture for plant growth and increases capacity for infiltration during precipitation events than other soil materials. Soil chemical properties differ from other wind blown and residual parent materials. It is easily eroded by wind when dry due to its particle size. The depth of ash mantles range from 7-20 inches. Purity has been grouped into four classes: 1) undisturbed "relatively pure" ash, 2) ash redistributed and mixed with other colluvial or eolian materials, 3) soil materials with only a minor influence of ash and 4) materials devoid of volcanic ash. Potential Natural Vegetation is strongly influenced by the presence and quality of ash mantle.

Identification of Mapping Differentia

The final step in survey design is to identify the array of mappable features within each mapping criteria and to construct a mapping legend to direct the mapping process. These features are called mapping differentia. Table 2 displays the final mapping differentia used to delineate the landscape into Landtype Associations. There were several steps before final mapping differentia were confirmed. These steps are discussed in detail in the next section. Table 2 lists all possible map unit components available for integration to create a Landtype Association. As will be illustrated later in Table 5, *Landtype Associations Identification Legend for Blue Mountains Ecoregion*, not all possible combinations occur within the survey area.

Table 2. Landtype Association Integration Legend - mapping differentia used to develop Landtype Associations

Vegetation Zones (PNV)		Geology Groups		Landforms	
1	Moist Forest (Grand Fir & Subalpine Fir)	1	Basic Igneous Rocks	1	Glacial Trough Floors
2	Dry Forest (Ponderosa Pine, Douglas Fir, & dry Grand Fir)	2	Clay Producing Materials	2	Glacial Trough Walls, Cirques & Alpine Ridges
3	Dry Non-Forest	3	Surficial: Glacial, Alluvial, Colluvial.	3	Alluvial Valley Floors
4	Moist Non-Forest	4	Lacustrine Interlays	4	Landslides
5	Rock, Non-Vegetated	5	Acid Igneous Rocks	5	Basins
6	Water	6	Exotic Terrane Rocks	6	Mountainslopes, gentle
7	Dry Forest Riparian	7	Sedimentary Rocks	7	Mountainslopes, steep
8	Parkland			8	Canyons

Mapping Procedures

Separate map layers for Vegetation Zones, Geology Groups, and Landforms were constructed using a draft list of mapping differentia. Existing data coverages in digital format were used to construct layers when available. Development methods of each map coverage are discussed in detail in the sections to follow.

The three map layers were then integrated using ARCGIS to form an initial Landtype Association (LTA) map. The resulting integrated map had 764 map units, many with only one or two polygons These original map units, referred to as LTA phases, were combined to develop groups of differentia for Landtype Associations. Broad similarity in ecological processes was the basis for grouping these LTA phases (Ottersberg 2002). A revised Landtype Associations integration legend and map were produced using these groupings and ARCGIS was used to make the combinations digitally to create the new map. The new combinations resulted in a map legend of 103 map units.

In 2006, the LTA map and legend underwent an addition review and revision. In preparation for development of management interpretations, mapping accuracy and consistency were checked against aerial photo interpretation and the map legend was reviewed for further need of combining small acreage delineations. Several map units were found to be too small in acreage or small in number and their combining with another map unit made little difference in interpretation of ecological processes at the LTA scale. Two map units with small acreage and small number of delineations were retained because of important features delineating riparian and slope stability processes. The aerial photographic review for mapping accuracy revealed errors in the primary vegetation map layer especially in identification of rock versus meadow or shrubfield. When discovered, these delineations were relabeled according to the aerial photograph interpretation. The landform layer had been generated by interpolating slope steepness and configuration from DEM generated contours. Some steep slopes adjacent or above glacial trough walls were mapped using a lower elevation LTA with similar slope steepness. Areas of extensive glaciated landscapes were reviewed in the GIS environment and re-delineated using heads-up digitizing. This correction was necessary to capture the interpretative differences of subalpine environments from canyon environments. It should be anticipated that not all of these errors where found and corrected, but many of the more consistent and most obvious errors in the vegetation and landform layer where corrected during correlation.

Approximately 270,000 additional acres in the Dooley Mountain and Snow Mountain areas were mapped independent of the integration process described above by using heads-up digitizing. Existing digital maps were overlain in the GIS environment to develop the LTA layer for these areas. Sources used were USFS digital orthophotographic quadrangles (DOQ), USDA Soil Resource Inventories, Baker County Soil Survey, and Oregon State geology map (Walker and McLeod 1991) that were available in digital format. An attempt was made to use the existing vegetation layer to infer Vegetation Zone but it was found to be less reliable than aerial photo interpretation.

A final map legend and map was then produced and after combining units and re-delineating others, 79 map units remain on the final map legend.

Below is a detailed discussion of methods and procedures used to generate each separate map for the three mapping criteria. The next section discusses the integration of these maps and correlation procedure to produce the final LTA map.

Landform

Geomorphic expression or landforms were identified and incorporated in the mapping legend as consistent as possible with *A Geomorphic Classification System* (Haskins and others 1996). Landforms were delineated using a combination of GIS slope modeling and heads-up digitizing landforms in the GIS environment using a digital elevation model (DEM) at 80-foot contour interval. Slope gradient associated with a specific geomorphic process was used to initially identify landforms. Slope shape and drainage patterns were used to further stratify these slope gradients into landforms with unique geomorphic expression. These are identified as LTA phase in Table 3 below. LTA phase landforms were aggregated to form Landtype Association landforms (column two in Table 3).

Table 3. Landform Groups – Landtype Association and Landtype Association Phase Names and Codes

LTA Code	LTA Landform Name (Draft Landform/ Process Name)	LTA phase Code	LTA phase Landform/Process Name
1	Trough Floors	FG	Moraines, gentle
	(Glacial Fill)	FS	Moraines, steep
2	Trough Walls, Cirques, & Alpine Ridges	SS	Scoured walls, steep
	(Glacial Scour)	SG	Scoured basins, gentle
		SU	Scoured landforms, undifferentiated
3	Alluvial Valley Floors	A	Alluvial, undifferentiated
	(Alluvial)	FPT	Flood Plains, Terraces
		TV	Tertiary Alluvial Valleys
		V	Alluvial Valley Fill
4	Landslides	LS	Landslide, Current
		M	Mass Failure, Potential
5	Basins, Fans, & Terraces	B	Basins, gentle
		BS	Basins, moderately steep
		CA	Colluvial/Alluvial (co-alluvial) Fans and Terraces
6	Mountain slopes, gentle	HG	Mountain slopes, gentle
		P	Plateaus
7	Mountain slopes, steep	HS	Mountain slopes, steep
		HS-A	Mountain slopes, steep-alpine
		S	Scarps and Structural Breaks
8	Canyons	C	Canyon
		CH	Convergent Headwall
		IG	Inner Gorge
		SB	Scarps and Structural Breaks, Very Steep

Geologic Groups

Three digital sources for geology were used to identify geologic groups. The Level V Ecoregion map produced for the Blue Mountains (Clarke and Bryce 1997) was used for the majority of the area. This resource does not cover portions of the Wallowa-Whitman National Forest and Malheur National Forest. A composite map of the Southern Blue Mountains (Applied Geologic Studies 1999) covered most of the remaining area. The Terrestrial Ecological Unit Inventory (USDA in progress) was used for the parts of Baker, Unity, and Pine Ranger Districts not covered by either of the other two maps. A small area east of the Snake River in Idaho was not covered by any of these resources and a level IV Ecoregion map was used to identify geologic boundaries in this area. The most useful resource for geology is the 1:100,000-scale Geology of Oregon map (Walker and MacLeod 1991). It was not used for the majority of the map because the digital version had scale and projection errors at the time of production in 2001. This source was used during the 2006 completion of mapping in the Dooley Mountain Area on the Unity District as projection errors had been corrected.

Geologic formations were grouped according to similar bedrock features such as rock type, mineralogy, resistance to weathering; and influence on known topographic, hydrologic, and soil features. These groupings are consistent with Clarke and Bryce (1997) and the previous Soil Resource Inventories for the National Forests.

Initial geologic groups developed for LTA phases were aggregated for LTAs. Further aggregation was based upon gross similarities that influence ecological processes or response similarly to disturbance. Some LTA phase geologic groups, that were of somewhat dissimilar properties but were of too small of extent to support in the LTA map legend, were combined. These groups were combined with the LTA group with the most similar properties. Table 4 below, lists the LTA phase geologic groups aggregated to LTA geologic groups and their respective map code.

Table 4. Geology Groups – Landtype Association and Landtype Association Phase Names and Codes

LTA Code	LTA Geology Group Name	LTA Phase Code	LTA Phase Geology Group Name
1	Basic Igneous Rocks	AB	Andesitic Basalt
		AN	Andesite
		ANB	Mixed Andesites and Basalts
		B	Basalt undifferentiated
		BA	Basalt and Andesite
		CB	Columbia River Basalts
		I	Imnaha Basalts
		PG	Picture Gorge basalts
		UM	Other mafic rocks associated with basalts
2	Clay Producing Materials	CTO	Clay producing tuffs
		LU	Lakebed clays
3	Surfacial: Glacial-undifferentiated Alluvial/Coalluvial - undifferentiated	GL	Glacial deposits
		GL-CBLAL	Glacial outwash
		LOB	Loess on Basalt
		O	Old alluvium
		U	Undifferentiated alluvium
		Y	Young alluvium

Table 4 (cont). Geology Groups – Landtype Association and Landtype Association Phase Names and Codes

LTA Code	LTA Geology Group Name	LTA Phase Code	LTA Phase Geology Group Name
4	Lacustrine Interlays	CBL	Basalt over lakebed sediments
5	Acid Igneous Rocks	G	Granite
		MM	Metamorphic (gneiss/schist)
		RT	Hard Welded Rhyolitic Tuffs
		T	Rhyolitic Tuffs of John Day Formation
6	Exotic Terrane Rocks	LT	Limestone
		MS	Metasediments
		MV	Metavolcanics
		MV-MS	Metavolcanics and metasediments
		MV-MS-G	Metavolcanics, metasediments, granite
		MV-S	Metavolcanics with serpentine
7	Sedimentary Rocks	SS	Sedimentary Sandstones

Vegetation Zones (PNV)

Vegetation Zones (PNV) are based upon the potential natural vegetation series of Plant Association Groups (PAG). PAG Maps were not available at the time of development and were constructed using existing vegetation data sources, including stand exams, to produce Plant Association Groups. Many PAG polygons were too small for Landtype Association scale and complexes or groups of PAGS were established where a repeating pattern was observed during delineations. PAG groups were named by the dominant one or two PAGs in the map unit; first named PAG is of greater proportionate extent in the map unit than the second named PAG. PAG groups were further aggregated into Vegetation Zones after the first integration exercise. The use of PAG groups created a map more the scale for Landtype than Landtype Association. Table 5 below, lists the PAG groups and the Vegetation Zones they were further grouped into for the final Landtype Association map.

During correlation and technical review, a new Vegetation Zone called Parkland was added to capture high elevation very cold forest and non-forest in an alpine or subalpine setting. This Vegetation Zone identifies areas were growth rates are severely influenced by temperature and wind. Some of these areas are within the CF-CNF PAG, which is grouped into the Moist Forest Vegetation Zone, but not all. A new PAG was created, VCNF-NF, which identifies those areas where recovery from disturbance is severely affected by climate from those areas where recovery from disturbance is only moderately affected by climate.

Table 5. Vegetation Zones (PNV): Landtype Association Codes and Landtype Association Phase Code and Plant Association Groups (PAGs) Map Units

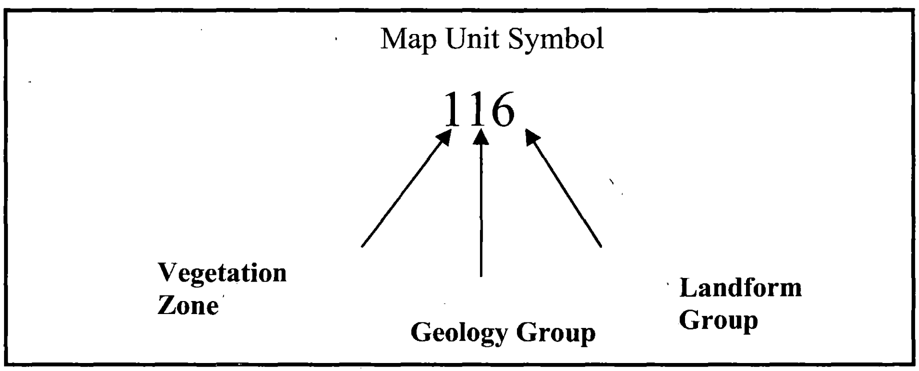
LTA Code	Vegetation Zone	LTA Phase Code	LTA Phase - PAG Map Units
1	Moist Forest	CF	Cold Forest
		CF-CNF	Cold Forest-Cold NonForest
		CF-DF	Cold Forest-Dry Forest
		CF-DG	Cold Forest-Dry Grass
		CF-MF	Cold Forest-Dry Shrub
		CF-MNF	Cold Forest Moist NonForest
		CF-MS	Cold Forest-Moist Shrub
		CF-RH	Cold Forest-Riparian Herbaceous
		CF-RI	Cold Forest-Riparian
		CF-RO	Cold Forest-Rock Outcrop
		MF	Moist Forest
		MF-CF	Moist Forest-Cold Forest
		MF-DF	Moist Forest-Dry Forest
		MF-DG	Moist Forest-Dry Grass
		MF-DS	Moist Forest-Dry Shrub
		MF-MNF	Moist Forest-Moist Non-Forest
2	Dry Forest	DF	Dry Forest
		DF-CF	Dry Forest-Cold Forest
		DF-DG	Dry Forest-Dry Grass
		DF-DS	Dry Forest-Dry Shrub
		DF-DW	Dry Forest-Dry Woodland
		DF-MF	Dry Forest-Moist Forest
		DF-MNF	Dry Forest-Moist NonForest
		DF-NF	Dry Forest-NonForest
		DF-RO	Dry Forest-Rock Outcrop
3	Dry Non-Forest	DG	Dry Grass
		DG-DS	Dry Grass-Dry Shrub
		DG-DW	Dry Grass-Dry Woodland
		DG-MF	Dry Grass-Moist Forest
		DG-OT	Dry Grass-Other
		DG-MNF	Dry Grass-Moist Non-Forest
		DG-MS	Dry Grass-Moist Shrub
		DG-RI	Dry Grass-Riparian
		DG-RO	Dry Grass-Rock Outcrop
		DG-RS	Dry Grass-Riparian Shrub
		Dry Grass-W	Dry Grass-Water
		DS	Dry Shrub
		DS-DG	Dry Shrub-Dry Grass
		DS-DW	Dry Shrub-Dry Woodland
		DS-MS	Dry Shrub-Moist Shrub
		DW	Dry Woodland
		DW-DG	Dry Woodland-Dry Grass
		DW-DS	Dry Woodland-Dry Shrub
4	Moist NonForest	MNF	Moist NonForest
		MNF-CNF	Moist NonForest-Cold NonForest
		MNF-DF	Moist Non-Forest-Dry Forest
		MNF-DG	Moist Non-Forest-Dry Grass
		MNF-MF	Moist NonForest-Moist Forest
		MS	Moist Shrub
		RS	Riparian Shrub
5	Rock, NonVegetation	NF	NonForest
		RO	Rock Outcrop
6	Water	W	Water
7	Dry Forest Riparian	DF-RH	Dry Forest-Riparian Herbaceous
		DF-RI	Dry Forest-Riparian
		DF-RS	Dry Forest-Riparian Shrub
8	Parkland	VCNF-NF	Very Cold Forest-NonForest

Integration and Correlation Procedure

As the Landtype Association phase mapping differentia was combined to form the final list of mapping differentia, a final LTA Integration Legend was developed (Table 2). The LTA phase maps were combined using ARCGIS and the resultant new delineations were relabeled. As with Landtype Association phase mapping differentia, the codes selected were intended to be somewhat connotative and unique. This coding system is a modified approach described by Arnold and Ryder (1993 and 1994, respectively).

The map unit symbols for LTAs were designed to be representative of the mapping criteria. They consist of three (3) numeric digits. The first digit represents the potential natural vegetation group, Vegetation Zone. The second digit represents the Geology Group. The third digit represents the Landform Group.

Figure 1. LTA Map Unit Symbols and Coding System



The initial computer-assisted integration of the individual map layers produce a draft map called Landtype Association Phase. The map unit size was more comparable to a Landtype level scale. The average size of map unit was 211 acres and the integration produced 674 map units, many with only one or two occurrences. Further combinations were made that resulted in the final draft Landtype Association Map. Tables 3, 4, and 5 on the previous pages document the map units for the individual map layer coverages and how these map units were combined to produce the Landtype Association Map. Decisions to combine were made on the basis of similar ecological processes useful to forest planning level analysis. The new combinations resulted in a legend with only 103 map units.

In 2006, a technical review and correlation resulted in further combining map units using the following guidelines:

- Map units were combined with a similar map unit when there were fewer than five delineations or less than 1500 acres and little interpretative difference with another map unit.

- Map unit delineations with less than three delineations and less than 100 acres in size were combined with adjacent map units.

- Map units with two or more delineations and more than 1000 acres with unique features important to forest level planning analysis were not combined, e.g., map units with riparian components, map units with unstable landscapes, map units with very slow growth rates due to climate

During the 2006 technical review and correlation, a review to check for consistency of mapped features within map units was conducted. The draft LTA map was overlain on aerial photography and topographic contour maps using ARCGIS. For several map units, it was observed that errors in feature labels had been transferred from most likely errors that existed in the base GIS data used to create the initial individual map coverages. These errors were most likely due to the method of map creation using multiple data sources in lieu of photo interpretation. When errors were discovered during the review, every delineation of that map unit where base data errors were suspect were examined and corrected, if necessary. Also, the new Vegetation Zone, Parkland, was delineated directly into the final Landtype Association Map using heads-up digitizing and aerial photograph interpretation. Thus, there is no corresponding Parkland PAG group delineated in the draft LTA phase map coverage for this Vegetation Zone. PAG group identified as CNF (Cold Non-Forest) is considered to be very similar.

Table 6 – *Landtype Association Identification Legend* in Part III contains a listing of all identified map units, their map labels or symbols, and a brief description of map unit components for the final map product. After final correlation, 79 map units are identified on the LTA Legend.

Using the Product

The correlation process resulted in a number of mapping edits to produce the final map of Landtype Associations. Because the final map is a composite of existing base information layers, it is only as accurate as the base layers. During final correlation, it was discovered that some of the vegetation interpretation from the vegetation layer was in error. Where these areas were noticed during the process of correlation, they were corrected, but it is likely there are more errors in the map. Some errors are to be expected due to the complexity of the project and condensed time constraints that required construction of the LTA map using existing base data with inherent errors and using GIS integration without adequate time allowed for visual or field validation of the map. That being said, the accuracy of the map is within acceptable accuracy limits as long as the map is used at the scale intended.

The best scale for map display is 1:100,000 but a range from 1:60,000 to 1:125,000 is acceptable. Map presentation scales less than 1:60,000 do not imply increases in accuracy or detail of mapping. The maps have utility for landscape planning or assisting other resource inventory projects. Unless properly interpreted and applied, LTA maps and interpretation tables will have less value for project level investigations and could be misleading. However, interpreted with the understanding of survey design, maps and interpretation tables can provide interpretative overviews for project studies. These

overviews may be adequate for some simple project designs and certainly in companion with more detailed map products, such as the Terrestrial Ecological Unit Inventory.

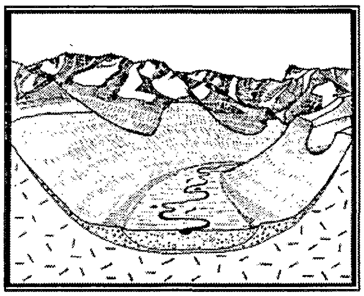
Once the user is familiar with development methods of the product, they likely will concentrate use in Part III containing the Landtype Association Identification Legend and Part IV containing management application interpretations. Part II Landtype Association Map Unit Components will be a useful reference for more detailed descriptions of the mapping differentia.

Part IV Landtype Association Management Applications should be used with the following understanding. Management applications include descriptions of physical properties of major site features, classifications, interpretations for major ecological processes, and natural disturbance regimes for each LTA. Descriptions are intended to reflect broad concepts as they affect ecological processes and are intentionally displayed as ranges not absolutes. Classifications are listed at the lowest hierarchical level possible and reflect concepts not absolutes. Classifications have been obtained either from overlaying specific data sources and constructing a list of the dominant classes or by empirical extrapolation. Interpretations are given as potential, hazard or limitations. An in-depth treatment of channel processes increases the utility of this product for watershed analysis. Detailed descriptions of each element in the table are provided in the section. The importance for understanding how the interpretation or description was obtained and how to interpret a rating of low, moderate or high prior to using these resources cannot be stressed enough.

PART II:
Landtype Association Map Unit Components

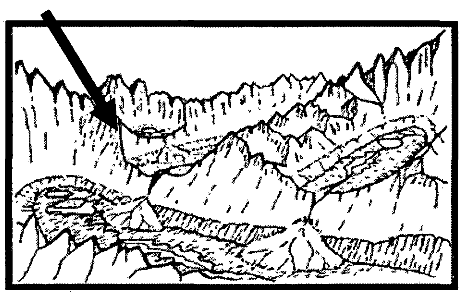
Landform Group Descriptions

1 Trough Floor



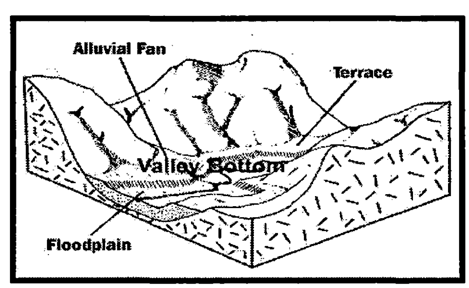
This landform occurs on till mantled slopes and valley floors of glacially eroded U-shaped valleys. Lower sideslopes are commonly concave and valley floors are gently sloping with irregular breaks where glacial scoured bedrock outcrops or glacial deposits occur. Slope gradients range from 10-50%. Alluvial fans, glacial moraines, and flood deposits are common in the landform. The landform is bisected by a larger order perennial stream channel usually with Rosgen B, C and E geomorphic types. Troughwalls meet the valley floor with high energy tributary channels that form fans in this landform. These streams often deliver high amounts of sediment to the mainstem stream causing channel migration at their confluence. Seeps are common along lower slopes. Soils have variable depth with high stone and boulder component.

2 Trough Walls, Cirques & Alpine Ridges



This landform occurs on extremely steep, rocky, irregular slopes and ridges with numerous cliffs and ledges and is on sideslopes and headwalls of U-shaped glacial valleys and smaller cirque basins. Sideslopes were scoured and over-steepened by glacial erosion forming defined ridgelines. Lower to midslope positions may have intermittent and perched glacial till deposits usually recognizable by a change from concave to convex slope shape and typically on one side of the valley and not on the other. Slope gradients range from 10 – 90 %. Cirque basins regulate stream temperature and flow throughout the season whereas steeper valley walls have high energy streams with rapid runoff. Bouldery talus accumulates below ledges and along the lower margin of this landform. Avalanche and debris chutes are common. Steep slopes have shallow residual soils. Slopes are moderately dissected by poorly defined, high gradient, low order, streams in a parallel drainage pattern.

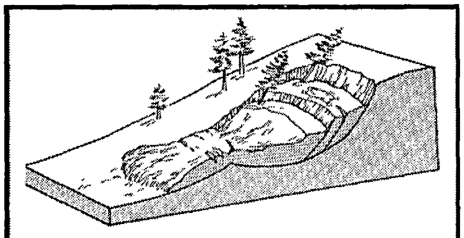
3 Alluvial Valley Floor



This landform occurs on remnant old terraces from previous valley floor levels, recent stream terraces, fans, and floodplains in broad valley floors and occasionally over a short distance within narrow canyons. Fluvial and a combination of colluvial/alluvial

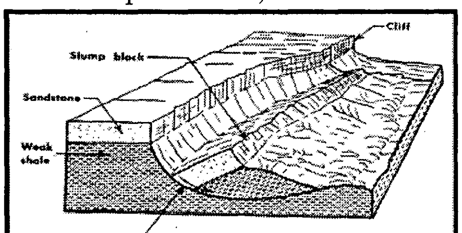
process are the primary land forming process. Slope gradients range from 0 to 15% and are dissected by low gradient, perennial streams commonly Rosgen B or C or locally, D geomorphic types. Substrate is usually comprised of stratified sand to cobble size material but very large boulders are not uncommon. Ponds, marshes and overflow channels may occur. Flood plains and low terraces on valley floors are subject to frequent flooding. Subsurface and in-stream flow may be in continuity. Included within this landform are alluvial fans and colluvial deposits located along the valley sides. This landform was mapped only in the less confined valleys.

4 Landslides



Rotational slide

This landform occurs on deep, large-scale landslide deposits. The landslide may be ancient and dormant or active and is formed in semi-consolidated or unconsolidated material. It consists of a series of benches intermixed with hummocky irregular mounds and depressions. Slope movement is commonly triggered by earthquakes, prolong periods of saturation, changes in toe slope ballast, accelerated weathering processes and/or flooding associated with glacial recession. Slope gradients range from 0-60%. Channels are low gradient and poorly defined and are weakly to moderately incised. They have a deranged to weakly dendritic pattern. Subsurface and surface drainage diverts water to depressions creating wet areas and seeps. Streams along landslide margins can destabilize the mass, locally reactivating a portion of a landslide mass. Some relict landslides are relatively stable and it is only along stream margins were they may be unstable.



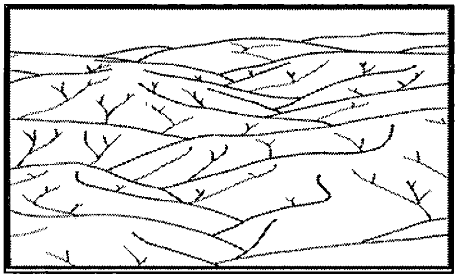
Rotational slump

5 Basins, Terraces, and Fans

This landform group includes several classes of landforms that formed by similar processes and have unique influences on watershed processes when compared to other LTA landforms. Basins have slopes that are generally concave in shape and range in slope gradient from 15- 50%. The landform shape naturally collects colluvium and runoff. Colluvial channels may store sediment over time and then release sediment in one large storm runoff event. Typically, runoff is regulated through a network of convergent small colluvial filled channels and swales or through infiltration into the regolith and slow release from bedrock layers. In gently sloping, basin headwater positions, stringers of wetlands are common. Springs may occur along breaks in slope on steeper slopes. Terraces are usually elevated above the valley floor perched along toeslopes of steeper landforms and are remnant from a previous valley floor level. The regolith is stratified and intercepts and releases runoff slowly along finer texture layers. If terraces are connected to the valley floor, they can be important in regulating groundwater to the stream channel flowing through the valley floor. Fans are usually relic landforms, formed from erosion of upper stream channels during extreme runoff events onto less vegetated areas and accumulating into a mass deposit of material where the slope gradient flattens. These events usually cause tributary and mainstem stream channel migration. This process is current today but less so and is usually initiated by vegetation removal from

wildfire followed by a long duration or high intensity convective storm or rapid snowmelt. Regolith is stratified which contributes to interception, retention, and slow groundwater release.

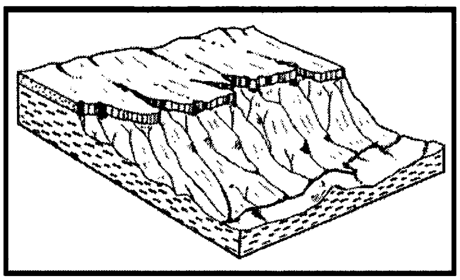
6 Mountain Slopes, Gentle



fluvial

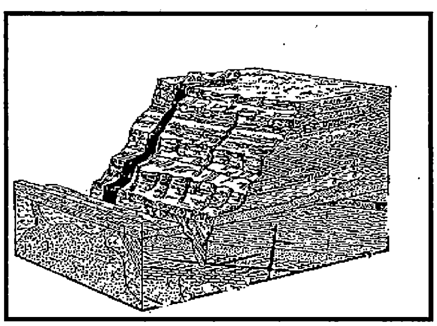
This landform includes summits and gentle undulating slopes of uplifted plateaus and backslopes. Slope gradients range from 0-30%. Productivity is directly related to soil depth. Soils are shallow on summits and somewhat deeper on backslopes. Deposition and erosion of wind blown parent material play a large role in determining soil characteristics. Mound/intermound geomorphology is common on summits and some backslopes. Erosional processes are mostly due to raindrop splash and dispersed overland flow. Drainage patterns are diffuse to dendritic, often exhibited as undefined swales on gentler gradients and form low order colluvial channels on steeper gradients.

7 Mountain Slopes, Steep



This landform was formed by uplift and subsequent stream erosion and occurs below mountain summits and backslopes. It is the most common landform and occurs on all geologic types. Slope gradients range from 30-60%. Drainage patterns are related to geologic type and are usually moderate in density and moderate in incision.

8 Canyons



This landform was formed by tectonic uplift and subsequent stream erosion generally along faultlines or other bedrock features that has caused differential erosion. The landform consists of high relief slopes with long steep colluvial slopes between bedrock outcrops or ledges. Steep bedrock controlled slopes form confined stream valleys where stream action at the base of the slope causes periodic instability with accelerated colluvial movement. Slope gradients range from 60-90 % or steeper on some bedrock types. Significant hydrologic events may scour colluvial and bedrock channels on sideslopes causing shallow rapid landslides forming fans at the base. Steep slope gradients have a high rate of colluvial downslope action leaving soils on upper and mid slope positions relatively shallow and soils along the footslope relatively deep. This dynamic equilibrium is easily altered by natural disturbances or by forest management.

Geology Group Descriptions

1 **Basic Igneous Rocks** This group includes basalt, andesitic basalts, andesite and other mafic rocks. The dominant bedrock is from Columbia River Basalt, Imnaha Basalt, and Picture Gorge Basalts of the Miocene Epoch. Lava flows accumulating overtime have a cumulative depth of over 2000 feet thick in some areas. This rock unit is structurally segmented by intermittent columnar jointing, fault fractures, and may have interbeds of weakly cemented sedimentary or pyroclastic deposits and relic soils formed between flow episodes. This segmentation provides for transfer to and storage to water bearing permeable layers within the strata. Bedrock is relatively resistant to weathering and forms outcrops. They may or may not require blasting during road construction. Parent materials weather to loams and clay loam soil textures. This rock group underwent general regional uplift and has formed gentle mountain dipslopes of plateaus and backslopes and steep canyons along fault lines and scarps.

2 **Clay Producing Materials** This group includes the Clarno Formation which consists of pyroclastic tuffs, interbedded andesite flows, and volcanic breccias. Associated are other clay producing materials, such as partially consolidated Tertiary lakebed sediments associated with the John Day Formation. This rock unit is highly stratified with thick and thin beds of variable structure and density; only the andesite layers and breccias are somewhat resistant to weathering but offer little resistant difficulty to road construction. Parent materials weather into clay loams, sandy clay loams, and silty clays soil textures. Landforms associated with this bedrock type are gentle and steep mountain slopes and landslides. Many of the relict, deep-seated landslides are associated with this rock group.

3 **Surficial: Glacial, Alluvial, Co-Alluvial** This group consists of alluvial, glacial, and co-alluvial deposits. Typically, they are unconsolidated and relatively recent deposits of Pleistocene age or partially consolidated or unconsolidated alluvium (remnant valley fill) of Tertiary age. These deposits are stratified, well-sorted or poorly sorted depending depositional process, and range from sandy to silty textures with high rock fragment content to very little rock fragment content. Perched water tables can occur in lenses of finer material and on top of cemented layers.

4 **Lacustrine Interlays** This group consists of lakebed sediments overlain by basalt flows. Weakly consolidated lacustrine material has low structural strength when saturated and is associated with landslides and small slumps. Soil textures are silty or sandy loam. Landforms associated with this geology group are landslide, gentle mountain slopes and steep mountain slopes. Seeps are commonly associated with this group.

5 **Acid Igneous Rocks** This group consists of granite and granodiorite intrusive rocks, rhyolitic tuffs of the John Day Formation, other hard welded rhyolitic tuffs, and gneiss or shists. Parent materials weather into sandy loam and coarse sandy loam soil textures and tend to have lower fertility that other parent materials. Landforms associated with this geology group are both gentle and steep mountain slopes and appear more rounded with complex slope shapes than for other geology groups. Roadcuts tend not to support vegetation well and soil ravel fills road ditches readily.

6 **Exotic Terrane Rocks** This group consists of Melange Formations of limestone rocks, metasedimentary rocks, metavolcanic rocks, pillow lava, gabbro and serpentine. These rocks originated over 200 million years ago along the border of two continental plates (subduction zone) where land mass is accreted and transformed by heat and pressure to a chaotic complex suite of rock types. Subsequent mountain uplift folded and fractured bedrock strata creating a complexity of differential weathering. As a result, landforms tend to have the greatest complexity in shape and slope gradients. Bedrock tends to be moderate in resistance to weathering in highly fractured zones but fairly resistant forming bedrock outcrops where strata are non-fractured. Soil textures are highly variable. Soils tend to be thin and rocky with low water holding capacity. Streams tend to dry up early in the season.

7 **Sedimentary Rocks** This group consists of sedimentary sandstones, siltstones, and shales originating from thick marine sediments of the same era as the Exotic Terrane Rocks. Sandstones are mostly graywackes and produce gravelly loam soils. Siltstones and shales produce gravelly loam and clay loam soils.

Vegetation Zone (PNV) Descriptions

1 **Moist Forest** This group consists of subalpine fir, grand fir, and Engleman spruce plant associations and represents forested areas undergoing the least moisture stress. This group is represented in all landform groups and tends to exist on northerly slope aspects. Soils have thick volcanic ash mantles that support higher forest productivity. These areas maintain persistent deep snow layers throughout the winter months. Mature stands at lower, warmer elevations are dominated by grand fir, ponderosa pine, western larch, and Douglas fir. Characteristic plant associations include ABGR/LIBO, ABGR/CLUN, and ABGR/VAME. Mature stands at higher colder elevations are dominated by lodgepole pine, western larch, subalpine fir, and Engleman spruce. Characteristic plant associations include ABLA/MEFE, ABLA/CLUN, ABLA/VAME, ABLA/ARCO and ABLA/VASC. Nearly homogenous stands of lodgepole pine at elevations where other species are expected to occur may indicate repetitive fire

history or cold air drainage or ponding, persistent soil wetness, and on soils with very low fertility. Small inclusions of PSME/VAME and the drier ABGR/SPBE or ABGR/CARU may occur where slope aspects change over small distances not recognized at landscape scale.

2 Dry Forest This group consists of Douglas fir, ponderosa pine, and dry grand fir associations and represents forested areas where moisture stress affects productivity. This group is represented in all landform groups and tends to occur on lowest elevation northerly slopes; on east/west slope aspects; and on higher elevation southerly aspects. Soils have variable thickness and disturbance of volcanic ash mantles depending on landform position and slope aspect. These areas may or may not have persistent deep snow layers throughout the winter months. Mature forests have overstories dominated by Douglas fir, ponderosa pine and grand fir. Western larch may occur in more moist plant associations. Characteristic plant associations include ABGR/CARU, ABGR/CAGE, PSME/VAME, PSME/PHMA, PSME/CARU, PSME/SYAL, PIPO/CARU, PIPO/SYAL, and PIPO/FEID. Small inclusions of non-forest or moist forest may occur where slope aspects change over short distances.

3 Dry, Non-Forest This group consists of open grown forests of ponderosa pine or Douglas fir; shrub steppe including sage and western juniper, and dry grasslands. This group is represented in all landform groups and tends to occur on lowest elevations and southerly aspects. Soils have mixed or no volcanic ash influence and usually have some loess influence. Winter snow melts quickly with the onset of spring temperatures and some areas may have ephemeral snow layers throughout the winter. Characteristic plant associations include PIPO/FEID, PIPO/CELE, PIPO/ARAR, PIPO/PSSPS, FEID/PSSPS, PSSPS/POSA, FEVI, ARTRV/FEID, JUOC/ARAR, JUOC/PUTR. Trees are easily removed from the environment with fire or other disturbance as they exist at their extreme range of their moisture tolerance in this vegetation zone. Grass productivity varies with soil depth and soil texture.

4 Moist Non-Forest This group consists of moist and wet meadows, riparian, and moist shrubfields. This group is generally associated with gentle mountain slopes and alluvial valley floors but does occur on steep subalpine mountain slopes. Soils are deep and have mixed ash mantles or minor volcanic ash influence. Soil moisture is abundant to excessive during the growing season. Characteristic plants and plant associations include aspen, sitka alder, sedge and bulrush species, FEVI subalpine meadow, FEVI/LULA, and willow.

5 Rock, Non-Vegetated This group consists of rock outcrop, talus, and boulder fields.

6 Water This group consists of large bodies of water.

7 <u>Dry Forest Riparian</u> This group consists of dry forests with significant riparian zones. This group is generally associated with broad headwater basins and unconfined lower elevation valley floors. Soils are very deep and have intermittent streams and significant groundwater near the surface that support riparian meadow and shrub complexes. Characteristic plants and plant associations include FEID/PSSPS, aspen, willow, and sedges in the riparian areas and ARTRV/PSSPS, PIPO/FEID, PIPO/PSSPS, and PIPO/SYAL on the more well drained areas.

8 Parkland This group consists of subalpine meadows and open grown subalpine forests. Landforms are broad convex ridges, steep mountain slopes associated with trough walls and alpine ridges. Soils are shallow to moderately deep and experience active disturbance from ground burrowing animals and from frost heave. Characteristic plants are FEVI, FEID/LULA, and a variety of meadow forbs. Scattered tree clusters or single trees are subalpine fir, Douglas-fir, whitebark pine, and Engleman spruce.

PART III:
Landtype Association Identification Legend

Table 6. Landtype Associations of the Blue Mountain Ecoregion - Map Unit Identification Legend

Landtype Association Identification Legend – Blue Mountains Ecoregion				
Map Symbol	**Vegetation Zones (PNV)**	**Bedrock Geology**	**Landform**	**Total Area (acres)**
114	Moist Forest	Basic Igneous Rocks	Landslide	4,583
115	Moist Forest	Basic Igneous Rocks	Basins, Fans, & Terraces	52,501
116	Moist Forest	Basic Igneous Rocks	Mountain slopes, gentle	885,861
117	Moist Forest	Basic Igneous Rocks	Mountain slopes, steep	297,421
118	Moist Forest	Basic Igneous Rocks	Canyons	310,077
124	Moist Forest	Clay Producing Materials	Landslide	24,019
125	Moist Forest	Clay Producing Materials	Basins, Fans, & Terraces	7,824
126	Moist Forest	Clay Producing Materials	Mountain slopes, gentle	115,584
127	Moist Forest	Clay Producing Materials	Mountain slopes, steep	38,070
131	Moist Forest	Surficial: Glacial-undifferentiated	Trough Floors	175,497
132	Moist Forest	Surficial: Glacial-undifferentiated	Glacial Trough Walls, Cirques, & Alpine Ridges	200,771
133	Moist Forest	Surficial: Alluvial/Colluvial undifferentiated	Alluvial Valley Floor	16,827
135	Moist Forest	Surficial: Alluvial/Colluvial undifferentiated	Basins, Fans, & Terraces	10,733
144	Moist Forest	Lacustrine Interlay	Landslide	29,677
146	Moist Forest	Lacustrine Interlay	Mountain slopes, gentle	15,359
155	Moist Forest	Acid Igneous Rocks	Basins, Fans, & Terraces	11,803
156	Moist Forest	Acid Igneous Rocks	Mountain slopes, gentle	83,188
157	Moist Forest	Acid Igneous Rocks	Mountain slopes, steep	69,760
158	Moist Forest	Acid Igneous Rocks	Canyons	7,874
165	Moist Forest	Exotic Terrane Rocks	Basins, Fans, & Terraces	907
166	Moist Forest	Exotic Terrane Rocks	Mountain slopes, gentle	116,532
167	Moist Forest	Exotic Terrane Rocks	Mountain slopes, steep	144,641
168	Moist Forest	Exotic Terrane Rocks	Canyons	40,057

Table 6. Landtype Associations of the Blue Mountain Ecoregion - Map Unit Identification Legend (cont)

Landtype Association Identification Legend – Blue Mountains Ecoregion				
Map Symbol	**Vegetation Zones (PNV)**	**Bedrock Geology**	**Landform**	**Total Area (acres)**
176	Moist Forest	Sedimentary Rocks	Mountain slopes, gentle	2,058
177	Moist Forest	Sedimentary Rocks	Mountain slopes, steep	1,179
214	Dry Forest	Basic Igneous Rocks	Landslide	10,075
215	Dry Forest	Basic Igneous Rocks	Basins, Fans, & Terraces	26,207
216	Dry Forest	Basic Igneous Rocks	Mountain slopes, gentle	883,338
217	Dry Forest	Basic Igneous Rocks	Mountain slopes, steep	274,116
218	Dry Forest	Basic Igneous Rocks	Canyons	289,101
224	Dry Forest	Clay Producing Materials	Landslide	9,522
226	Dry Forest	Clay Producing Materials	Mountain slopes, gentle	91,336
227	Dry Forest	Clay Producing Materials	Mountain slopes, steep	32,144
231	Dry Forest	Surficial: Glacial	Trough Floors	5,960
232	Dry Forest	Surficial: Glacial	Glacial Trough Walls, Cirques, & Alpine Ridges	8,176
233	Dry Forest	Surficial: Alluvial/Colluvial undifferentiated	Alluvial Valley Floors	27,184
236	Dry Forest	Surficial: Alluvial/Colluvial undifferentiated	Mountain slopes, gentle	6,594
244	Dry Forest	Lacustrine Interlay	Landslide	12,415
246	Dry Forest	Lacustrine Interlay	Basins, Fans, & Terraces	5,450
256	Dry Forest	Acid Igneous Rocks	Mountain slopes, gentle	133,143
257	Dry Forest	Acid Igneous Rocks	Mountain slopes, steep	40,938
258	Dry Forest	Acid Igneous Rocks	Canyons	8,238
265	Dry Forest	Exotic Terrane Rocks	Basins, Fans, & Terraces	8,132
266	Dry Forest	Exotic Terrane Rocks	Mountain slopes, gentle	97,512
267	Dry Forest	Exotic Terrane Rocks	Mountain slopes, steep	77,372
268	Dry Forest	Exotic Terrane Rocks	Canyons	30,644
273	Dry Forest	Sedimentary Rocks	Alluvial Valley Floors	425
275	Dry Forest	Sedimentary Rocks	Basins, Fans, & Terraces	17,631
276	Dry Forest	Sedimentary Rocks	Mountain slopes, gentle	73,940
277	Dry Forest	Sedimentary Rocks	Mountain slopes, steep	22,373
315	Dry NonForest	Basic Igneous Rocks	Basins, Fans, & Terraces	3,029

Table 6. Landtype Associations of the Blue Mountain Ecoregion - Map Unit Identification Legend (cont)

Landtype Association Identification Legend – Blue Mountains Ecoregion				
Map Symbol	**Vegetation Zones (PNV)**	**Bedrock Geology**	**Landform**	**Total Area (acres)**
316	Dry NonForest	Basic Igneous Rocks	Mountain slopes, gentle	124,271
317	Dry NonForest	Basic Igneous Rocks	Mountain slopes, steep	75,154
318	Dry NonForest	Basic Igneous Rocks	Canyons	204,922
326	Dry NonForest	Clay Producing Materials	Mountain slopes, gentle	2,266
327	Dry NonForest	Clay Producing Materials	Mountain slopes, steep	933
332	Dry NonForest	Surficial: Glacial-undifferentiated	Alluvial Valley Floors	6,013
333	Dry NonForest	Surficial: Alluvial/Colluvial undifferentiated	Alluvial Valley Floors	21,271
356	Dry NonForest	Acid Igneous Rocks	Mountain slopes, gentle	119,370
357	Dry NonForest	Acid Igneous Rocks	Mountain slopes, steep	15,723
358	Dry NonForest	Acid Igneous Rocks	Canyons	17,194
365	Dry NonForest	Exotic Terrane Rocks	Basins, Fans, & Terraces	1,692
366	Dry NonForest	Exotic Terrane Rocks	Mountain slopes, gentle	3,874
367	Dry NonForest	Exotic Terrane Rocks	Mountain slopes, steep	20,983
368	Dry NonForest	Exotic Terrane Rocks	Canyons	38,334
376	Dry NonForest	Sedimentary Rocks	Mountain slopes, gentle	9,958
377	Dry NonForest	Sedimentary Rocks	Mountain slopes, steep	1,869
416	Moist NonForest	Basic Igneous Rocks	Mountain slopes, gentle	13,585
418	Moist NonForest	Basic Igneous Rocks	Canyons	27,286
432	Moist NonForest	Surficial: Glacial-undifferentiated	Glacial Trough Walls, Cirques, & Alpine Ridges	7,653
433	Moist NonForest	Surficial: Alluvial/Colluvial undifferentiated	Alluvial Valley Floors	8,829
468	Moist NonForest	Exotic Terrane Rocks	Canyons and Very Steep Slopes	7,937
518	Rock/Sparse Vegetation	Basic Igneous Rocks	Canyons and Very Steep Slopes	23,486
532	Rock/Sparse Vegetation	Surficial: Glacial-undifferentiated	Glacial Trough Walls, Cirques, & Alpine Ridges	46,780
558	Rock/Sparse Vegetation	Acid Igneous Rocks	Canyons	5,722

Table 6. Landtype Associations of the Blue Mountain Ecoregion - Map Unit Identification Legend (cont)

Landtype Association Identification Legend – Blue Mountains Ecoregion				
Map Symbol	**Vegetation Zones (PNV)**	**Bedrock Geology**	**Landform**	**Total Area (acres)**
567	Rock/Sparse Vegetation	Exotic Terrane Rocks	Mountain slopes, steep	3,419
568	Rock/Sparse Vegetation	Exotic Terrane Rocks	Canyons	9,387
600	WATER			2,602
736	Dry Forest/Riparian	Surficial: Alluvial/Colluvial undifferentiated	Mountain slopes, gentle	5,099
832	Parkland	Surficial: Glacial-undifferentiated	Glacial Trough Walls, Cirques, & Alpine Ridges	60,175
Grand Total				**5,895,989**

PART IV:
Landtype Associations Management Applications

This section contains lists of properties, hazard ratings, limitations or suitability for management consideration, and potential response to natural disturbance. Properties are developed from field observation and aerial photo interpretation. Properties are listed on order of their dominance or importance to major ecological processes in a Landtype Association (LTA). Ratings are relative to each other and are derived mostly from empirical interpretation of dominant processes identified with each Landtype Association and field observation. Suitability for management and limitations to management are based upon referenced criteria and conditions that present potential degradation or increased cost in development to avoid degradation. Potential responses to natural disturbances are extrapolated from research literature by applying regionally or nationally recognized classification systems to processes identified for each Landtype Association. Narrative sections prior to interpretation tables contain definitions, sources, and clarifications important to understanding the qualification of the interpretation. It is important to read these sections prior to using the interpretation tables.

The same information is available in digital format with the map coverage in ARCGIS environment. A series of databases (using ACCESS) can be formatted to make tables suited to user needs and for only the LTAs of interest. Tables in this report provide information in subject areas most commonly needed by most users, but most importantly, documents the basis for the interpretations.

There are many uses for this information. Table 7 lists geomorphic processes in order of occurrence and provides a general summary of physical features needed for more general types of analysis. This is useful to those seeking a basic understanding of landform genesis and to compare basic LTA concepts. Table 8 identifies representative soil components for each LTA and their physical properties, and provides a more detailed look at the variation of physical properties within each LTA. Tables 9 and 10 provide interpretations useful to understanding watershed processes and information that assists in rating relative risk to watersheds from management activities or natural disturbance. Table 11 provides information relative to wildlife and fisheries habitats useful to landscape analysis. Table 12 and Table 13 provide information useful in vegetation management including productivity interpretations and suitability for use in timber and grazing management.

Landtype Association Geomorphic Processes and General Physical Properties

Table 7 contains a list of dominant geomorphic processes, both relic and active, that influenced landforms and surficial properties, as they exist today. Other general physical properties are summarized for each LTA. These summaries are provided for users interested in a brief overview of geomorphic differences between Landtype

Associations. The information is an aggregate of the more detailed information by soil component that is contained in Table 8, Soil Classification and Properties.

Landform: This column lists the landform group name for the Landtype Association. A narrative description is provided in Section II.

Dominant Bedrock: This column lists the most commonly occurring bedrock for each Landtype Association. Not all combinations of differentia occur with all map criteria and this column identifies which bedrock most commonly occurs with the other map differentia for a particular Landtype Association. Undifferentiated is used where the distinction was not made for surficial deposits originating from any number of kinds of bedrock materials.

Relict and Active Geomorphic Processes: These two columns list the geomorphic processes as identified using *A Geomorphic Classification System* (Haskins et al 1996). The nomenclature is as closely matching this reference as possible but not exactly. Subprocesses within major processes are too complex to discern at the Landtype Association scale. Relic processes are those that have occurred in the geologic past but are continuing to influence geomorphic processes through landform shape, landscape position, and soil development. These processes are listed in order of time sequence with the oldest being listed first. Only the major relic land-forming processes continuing to influence active processes are listed. Active processes are listed in order of time sequence and dominance. Time sequence of distinct and separate processes are separated by a slash (/) whereas those processes that may be related or resultant from another process are separated by an "and". A comma (,) separation denotes that the processes may occur concurrently or sequentially.

Slope Gradient: This column contains an average range or dominant slope gradient range in percent of each map unit. Exceptions will occur within the map unit but are expected to be of minor extent.

Volcanic Ash: This column lists four of the five classes of volcanic ash mantle: thick mantle, thin mantle, mixed ash, and no ash or no influence. Minor ash class is of lesser extent and was combined with mixed ash for this table. Entries in this column are a summary of the variation for the entire map unit. For extent of all the classes within an LTA, consult Table 8, Soil Classification and Properties.

Distribution of volcanic ash serves as an index to erosion, deposition, fire frequency, cover by vegetation and litter, and general landscape stability. Thicker layers indicate more stable or depositional environments while thinner layers indicate erosional environments and possibly higher fire frequency. And, generally, distribution, depth, and ash disturbance (i.e. mixing) are correlated with slope gradient, slope position, and slope aspect. Thick, undisturbed ash mantles occur on north aspects and mid to higher elevation gentle slopes and support moist forest. Although of minor extent in the landscape, ash deposits, ten or more feet thick, remain on protected landscape segments along toeslopes of steep mountain slopes and plateau scarps. Drifts, flows, avalanches and slides of ash; energized by wind, water and gravity accumulated ash into these spectacular deposits. Mounds of volcanic ash, redistributed by wind commonly occur on backslopes of plateaus and are less common on plateau summits. Mixed ash occurs on

colluvial foot slopes, climatic zones with more frequent fire and areas that receive significant loess deposition. Soil materials in flood plains and low terraces on valley floors are devoid of ash having been washed away by floods since ash was deposited.

The following classes define the amount or influence of volcanic ash for each LTA.

Ash mantles (>60 percent volcanic ash; >7 inches thick)

Thick (> 14 inches thick)

Thin (7-14 inches thick)

Mixed ash (30-60 percent volcanic ash; >7 inches thick)

No ash influence (0-5 percent volcanic ash)

Regolith Texture: Regolith texture is of the unconsolidated material from the base of the surface layer to a bedrock contact. In the case of regoliths with ash mantles, the regolith texture may be vastly different that the surface texture. Ash mantle textures fall within the medium textural class. Textures are grouped using the Soil Textural Classes defined in the USDA Soil Survey Manual (USDA Soil Survey 1993).

Soil Textural Classes are as follows:

coarse - sands and loamy sands

moderately coarse - sandy loams

medium - very fine sands, loams, silt loams, and silt

moderately fine - clay loams, sandy clay loams, and silty clay loams

fine- sandy clay, silty clay, and clay

Depth to Bedrock: This column contains the average range of depth to hard bedrock based upon soil descriptions from the Landtype (TEUI) inventory and empirical interpretation of exceptions that are anticipated to occur. For more detail about extent of the various soil depths for a LTA, consult Table 7.

Table 7. Landtype Association Geomorphic Processes and General Physical Properties

LTA	Landform	Dominant Bedrock	Relict Geomorphic Process	Active Geomorphic _Process	Slope Gradient (%)	Volcanic Ash	Regolith Texture	Depth to Bedrock
114	Landslides	Basalt	Lava Flow/Uplift/Eolian	Landslide	30 to 60	thick	medium	3-20
115	Basins, Fans, and Terraces	Basalt	Lava Flow/Uplift/Eolian	Fluvial and Pluvial Erosion/Deposition	15 to 50	thick	medium	3-10
116	Mountain Slopes, Gentle	Basalt	Lava Flow/Uplift/Eolian	Pluvial and Wind Erosion	0 to 30	thick	medium	2-5
117	Mountain Slopes, Steep	Basalt	Lava Flow/Uplift/Eolian	Fluvial and Colluvial Erosion	30 to 60	thick	medium	3-20
118	Canyons	Basalt	Lava Flow/Uplift/Eolian	Fluvial, Mass Wasting, and Colluvial Erosion	60 to 90	thick & mixed	medium to moderately fine	<1-10
124	Land Slide	Volcanic tuffs and lakebed clays	Pyroclastic Flow/Uplift/Eolian	Landslide	0 to 60	thick	moderately fine to fine	2-20
125	Basins, Fans, and Terraces	Volcanic tuffs and lakebed clays	Pyroclastic Flow/Uplift/Eolian	Fluvial and Pluvial Erosion/Deposition	15 to 50	thick	moderately fine to fine	3-10
126	Mountain Slopes, Gentle	Volcanic tuffs and lakebed clays	Pyroclastic Flow/Uplift/Eolian	Pluvial and Wind Erosion	0 to 30	thick	moderately fine to fine	2-10
127	Mountain Slopes, Steep	Volcanic tuffs and lakebed clays	Pyroclastic Flow/Uplift/Eolian	Fluvial and Colluvial Erosion	30 to 60	thick	fine to moderately fine	2-5
131	Trough Floors	Undifferentiated	Glaciation/Glacial Deposition/Eolian	Fluvial Erosion	10 to 50	thick	moderately coarse	3-20
132	Trough Walls, Cirques, & Alpine Ridges	Undifferentiated	Glaciation/Glacial Erosion/Eolian	Fluvial, Mass Wasting, Colluvial Erosion	10 to 90	thick	moderately coarse	0-10
133	Alluvial Valley Floors	Undifferentiated	Tectonic Faulting/Eolian/Stream Processes	Fluvial Erosion/Deposition	0 to 15	no influence & thick	moderately coarse to moderately fine	>20
135	Basins, Fans, and Terraces	Undifferentiated	Undifferentiated/Eolian/ Fluvial/MassWasting/Eolian	Mass Wasting/Fluvial Erosion and Deposition	15 to 50	no influence & thick	moderately fine to moderately coarse	10-20
144	Land Slide	Basalt interlayed with lacustrine sediments	Lacustrine/Volcanic Flow/Eolian	Landslide	0 to 60	thick	moderately fine to fine	3-20
146	Mountain Slopes, Gentle	Basalt interlayed with lacustrine sediments	Lacustrine/Volcanic Flow/Eolian	Pluvial and Wind Erosion, Landslide	0 to 30	thick	medium to fine	3-10
155	Basins, Fans, and Terraces	Rhyolitic tuff, Granite, Gneiss/Schist.	PyroclasticFlows and IgneousIntrusives/Uplift/Eolian	Fluvial and Pluvial Erosion/Deposition	15 to 50	thick	medium	3-5

Table 7. Landtype Association Geomorphic Processes and General Physical Properties (cont)

LTA	Landform	Dominant Bedrock	Relict Geomorphic Process	Active Geomorphic _Process	Slope Gradient (%)	Volcanic Ash	Regolith Texture	Depth to Bedrock
156	Mountain Slopes, Gentle	Rhyolitic tuff, Granite, Gneiss/Schist.	PyroclasticFlows and IgneousIntrusives/Uplift/Eolian	Pluvial and Wind Erosion	0 to 30	thick	moderately coarse	3-5
157	Mountain Slopes, Steep	Rhyolitic tuff, Granite, Gneiss/Schist.	PyroclasticFlows and IgneousIntrusives/Uplift/Eolian	Fluvial and Colluvial Erosion	30 to 60	thick	moderately coarse	3-5
158	Canyons	Rhyolitic tuff, Granite, Gneiss/Schist.	PyroclasticFlows and IgneousIntrusives/Uplift/Erosion/Eolian	Fluvial and Colluvial Erosion	60 to 90	thick & mixed	moderately coarse to coarse	2-5
165	Basins, Fans, and Terraces	Metavolcanic, Metasedimentary, Serpentine	Tectonic Folding/Uplift/Eolian	Fluvial and Pluvial Erosion/Deposition	15 to 50	thin & thick	moderately coarse to medium	2-10
166	Mountain Slopes, Gentle	Metavolcanic, Metasedimentary, Serpentine	Tectonic Folding/Uplift/Eolian	Pluvial and Wind Erosion	0 to 30	thin & thick	moderately coarse to medium	2-3
167	Mountain Slopes, Steep	Metavolcanic, Metasedimentary, Serpentine	Tectonic Folding/Uplift/Eolian	Fluvial and Colluvial Erosion	30 to 60	thick & mixed	moderately fine to moderately coarse	3-10
168	Canyons	Metavolcanic, Metasedimentary, Serpentine	Tectonic Folding/Uplift/Eolian	Fluvial, Mass Wasting, and Colluvial Erosion	60 to 90	thick & mixed	moderately fine to moderately coarse	2-10
176	Mountain Slopes, Gentle	Sedimentary Sandstones	Tectonic-Undiff./Uplift/Eolian	Pluvial and Wind Erosion	0 to 30	mixed	medium to moderately fine	<1-3
177	Mountain Slopes, Steep	Sedimentary Sandstones	Tectonic-Undiff./Uplift/Eolian	Fluvial and Colluvial Erosion	30 to 60	thick & mixed	moderately fine to medium	<1-5
214	Land Slide	Basalt	Lava Flow/Uplift/Eolian	Landslide	0 to 60	mixed	fine to moderately fine	3-10
215	Basins, Fans, and Terraces	Basalt	Lava Flow/Uplift/Eolian	Fluvial and Pluvial Erosion/Deposition	15 to 50	mixed	moderately fine	2-5
216	Mountain Slopes, Gentle	Basalt	Lava Flow/Uplift/Eolian	Pluvial and Wind Erosion	0 to 30	mixed	moderately fine to medium	2-5
217	Mountain Slopes, Steep	Basalt	Lava Flow/Uplift/Eolian	Fluvial and Colluvial Erosion	30 to 60	mixed	moderately fine to medium	3-10
218	Canyons	Basalt	Lava Flow/Uplift/Erosion/ Eolian	Fluvial, Mass Wasting, and Colluvial Erosion	60 to 90	mixed	moderately fine to medium	<1-5

Table 7. Landtype Association Geomorphic Processes and General Physical Properties (cont)

LTA	Landform	Dominant Bedrock	Relict Geomorphic Process	Active Geomorphic _Process	Slope Gradient (%)	Volcanic Ash	Regolith Texture	Depth to Bedrock
224	Land Slide	Volcanic tuffs and lakebed clays	Pyroclastic Flow/Uplift/Eolian	Landslide	0 to 60	mixed and thin	fine to moderately fine	3-20
226	Mountain Slopes, Gentle	Volcanic tuffs and lakebed clays	Pyroclastic Flow/Uplift/Eolian	Pluvial and Wind Erosion	0 to 30	mixed	moderately fine to fine	2-5
227	Mountain Slopes, Steep	Volcanic tuffs and lakebed clays	Pyroclastic Flow/Uplift/Eolian	Fluvial and Colluvial Erosion	30 to 60	mixed	moderately fine to fine	2-5
231	Trough Floors	Undifferentiated	Glaciation/Glacial Deposition/Eolian	Fluvial Erosion	10 to 50	thick & mixed	moderately coarse	3-20
232	Trough Walls, Cirques, & Alpine Ridges	Undifferentiated	Glaciation/Glacial Erosion/Eolian	Fluvial, Mass Wasting, Colluvial Erosion	10 to 90	thick & mixed	moderately coarse	0-20
233	Alluvial Valley Floors	Undifferentiated	Tectonic Faulting/Eolian/Stream Processes	Fluvial Erosion/Deposition	0 to 15	mixed and thin	moderately fine to medium	>20
236	Mountain Slopes, Gentle	Undifferentiated	Tectonic Uplift/Eolian/Stream Processes	Fluvial Erosion/Deposition	0 to 30	mixed and thin	moderately fine to medium	>20
244	Land Slide	Basalt interlayed with lacustrine sediments	Lacustrine/Volcanic Flow/Eolian	Landslide	0 to 60	mixed	fine to moderately fine	2-10
246	Mountain Slopes, Gentle	Basalt interlayed with lacustrine sediments	Lacustrine/Volcanic Flow/Eolian	Pluvial and Wind Erosion, Landslide	0 to 30	mixed	fine to moderately fine	2-5
256	Mountain Slopes, Gentle	Rhyolitic tuff, Granite, Gneiss/Schist.	PyroclasticFlows and IgneousIntrusives/Uplift/Eolian	Pluvial and Wind Erosion	0 to 30	thick & mixed	medium	2-5
257	Mountain Slopes, Steep	Rhyolitic tuff, Granite, Gneiss/Schist.	PyroclasticFlows and IgneousIntrusives/Uplift/Eolian	Fluvial and Colluvial Erosion	30 to 60	thick & mixed	moderately fine to medium	3-5
258	Canyons	Rhyolitic tuff, Granite, Gneiss/Schist.	PyroclasticFlows and IgneousIntrusives/Uplift/ Erosion/Eolian	Fluvial, Mass Wasting, and Colluvial Erosion	60 to 90	mixed	medium	1-5
265	Basins, Fans, and Terraces	Metavolcanic, Metasedimentary, Serpentine	Tectonic Folding/Uplift/Eolian	Fluvial and Pluvial Erosion/Deposition	15 to 50	mixed and thin	moderately coarse	2-20
266	Mountain Slopes, Gentle	Metavolcanic, Metasedimentary, Serpentine	Tectonic Folding/Uplift/Eolian	Pluvial and Wind Erosion	0 to 30	mixed	moderately fine to medium	<1-3
267	Mountain Slopes, Steep	Metavolcanic, Metasedimentary, Serpentine	Tectonic Folding/Uplift/Eolian	Fluvial and Colluvial Erosion	30 to 60	mixed and thin	medium to moderately coarse	2-10

Table 7. Landtype Association Geomorphic Processes and General Physical Properties (cont)

LTA	Landform	Dominant Bedrock	Relict Geomorphic Process	Active Geomorphic _Process	Slope Gradient (%)	Volcanic Ash	Regolith Texture	Depth to Bedrock
268	Canyons	Metavolcanic, Metasedimentary, Serpentine	Tectonic Folding/Uplift/Eolian	Fluvial, Mass Wasting, and Colluvial Erosion	60 to 90	mixed and thin	medium	<1-3
273	Alluvial Valley Floors	Sedimentary Sandstones	Tectonic Faulting/Eolian/Stream Processes	Fluvial Erosion/Deposition	0 to 15	no influenced and mixed	medium to moderately fine	<1-5
275	Basins, Fans, and Terraces	Sedimentary Sandstones	Tectonic-undiff/Fluvial/Mass Wasting/Eolian	Mass Wasting/Fluvial Erosion and Deposition	15 to 50	mixed	medium	<1-3
276	Mountain Slopes, Gentle	Sedimentary Sandstones	Tectonic-Undiff./Uplift/Eolian	Pluvial and Wind Erosion	0 to 30	mixed	moderately fine to medium	<1-3
277	Mountain Slopes, Steep	Sedimentary Sandstones	Tectonic-Undiff./Uplift/Eolian	Fluvial and Colluvial Erosion	30 to 60	mixed	moderately fine to medium	<1-5
315	Basins, Fans, and Terraces	Basalt	Lava Flow/Uplift/Eolian	Fluvial and Pluvial Erosion	15 to 50	mixed	moderately coarse to medium	2-5
316	Mountain Slopes, Gentle	Basalt	Lava Flow/Uplift/Eolian	Pluvial and Wind Erosion	0 to 30	mixed	medium	<1-2
317	Mountain Slopes, Steep	Basalt	Lava Flow/Uplift/Eolian	Fluvial and Colluvial Erosion	30 to 60	mixed	medium	<1-3
318	Canyons	Basalt	Lava Flow/Uplift/Erosion/ Eolian	Fluvial, Mass Wasting, and Colluvial Erosion	60 to 90	mixed	medium	<1-3
326	Mountain Slopes, Gentle	Volcanic tuffs and lakebed clays	Pyroclastic Flow/Uplift/Eolian	Pluvial and Wind Erosion	0 to 30	mixed	fine	<1-3
327	Mountain Slopes, Steep	Volcanic tuffs and lakebed clays	Pyroclastic Flow/Uplift/Eolian	Fluvial and Colluvial Erosion	30 to 60	mixed	fine	<1-3
332	Trough Walls, Cirques, & Alpine Ridges	Undifferentiated	Glaciation/Glacial Erosion/Eolian	Fluvial, Mass Wasting, Colluvial Erosion	10 to 90	mixed	moderately coarse to coarse	0-10
333	Alluvial Valley Floors	Undifferentiated	Tectonic Faulting/Eolian/Stream Processes	Fluvial Erosion/Deposition	0 to 15	mixed	moderately fine to fine	>20
356	Mountain Slopes, Gentle	Rhyolitic tuff, Granite, Gneiss/Schist.	PyroclasticFlows and IgneousIntrusives/Uplift/Eolian	Pluvial and Wind Erosion	0 to 30	no influence and mixed	moderately coarse	<1-2
357	Mountain Slopes, Steep	Rhyolitic tuff, Granite, Gneiss/Schist.	PyroclasticFlows and IgneousIntrusives/Uplift/Eolian	Fluvial and Colluvial Erosion	30 to 60	no influence and mixed	moderately coarse	<1-10
358	Canyons	Rhyolitic tuff, Granite, Gneiss/Schist.	PyroclasticFlows and IgneousIntrusives/Uplift/ Erosion/Eolian	Fluvial, Mass Wasting, and Colluvial Erosion	60 to 90	mixed	medium	0-2

Table 7. Landtype Association Geomorphic Processes and General Physical Properties (cont)

LTA	Landform	Dominant Bedrock	Relict Geomorphic Process	Active Geomorphic _Process	Slope Gradient (%)	Volcanic Ash	Regolith Texture	Depth to Bedrock
365	Basins, Fans, and Terraces	Metavolcanic, Metasedimentary, Serpentine	Tectonic Folding/Uplift/Eolian	Fluvial and Pluvial Erosion/Deposition	15 to 50	mixed	medium	<1-2
366	Mountain Slopes, Gentle	Metavolcanic, Metasedimentary, Serpentine	Tectonic Folding/Uplift/Eolian	Pluvial and Wind Erosion	0 to 30	mixed	medium	<1-2
367	Mountain Slopes, Steep	Metavolcanic, Metasedimentary, Serpentine	Tectonic Folding/Uplift/Eolian	Fluvial and Colluvial Erosion	30 to 60	thick and thin	moderately coarse	3-5
368	Canyons	Metavolcanic, Metasedimentary, Serpentine	Tectonic Folding/Uplift/Erosion/Eolian	Fluvial, Mass Wasting, and Colluvial Erosion	60 to 90	mixed	medium	<1-2
376	Mountain Slopes, Gentle	Sedimentary Sandstones	Tectonic-Undiff./Uplift/Eolian	Pluvial and Wind Erosion	0 to 30	mixed	medium	<1-2
377	Mountain Slopes, Steep	Sedimentary Sandstones	Tectonic-Undiff./Uplift/Eolian	Fluvial and Colluvial Erosion	30 to 60	mixed	medium	<1-3
416	Mountain Slopes, Gentle	Basalt	Lava Flow/Uplift/Eolian	Pluvial and Wind Erosion	0 to 30	mixed	medium	2-5
418	Canyons	Basalt	Lava Flow/Uplift/Eolian	Fluvial, Mass Wasting, and Colluvial Erosion	60 to 90	mixed	medium	2-5
432	Trough Walls, Cirques, & Alpine Ridges	Undifferentiated	Glaciation/Glacial Erosion/Eolian	Fluvial, Mass Wasting, Colluvial Erosion	10 to 90	mixed	medium	0-2
433	Alluvial Valley Floors	Undifferentiated	Undifferentiated/Eolian/ Stream Processes	Fluvial Erosion and Deposition	0 to 15	no influence	moderately coarse	10-20
468	Canyons	Metavolcanic, Metasedimentary, Serpentine	Tectonic Folding/Uplift/Erosion/ Eolian	Fluvial, Mass Wasting, and Colluvial Erosion	60 to 90	mixed	medium	0-2
518	Canyons	Basalt	Lava Flow/Uplift/Erosion	Fluvial, Mass Wasting, and Colluvial Erosion	60 to 90	n/a	n/a	0-1
532	Trough Walls, Cirques, & Alpine Ridges	Undifferentiated	Glaciation/Glacial-Periglacial Erosion	Fluvial, Mass Wasting, and Colluvial Erosion	10 to 90	n/a	n/a	0-1
558	Canyons	Rhyolitic tuff, Granite, Gneiss/Schist.	PyroclasticFlows and IgneousIntrusives/Uplift/ Erosion	Fluvial, Mass Wasting, and Colluvial Erosion	60 to 90	n/a	n/a	0-1
567	Mountain Slopes, Steep	Metavolcanic, Metasedimentary, Serpentine	Tectonic Folding/Uplift/Erosion	Fluvial, Mass Wasting, and Colluvial Erosion	30 to 60	n/a	n/a	0-1

Table 7. Landtype Association Geomorphic Processes and General Physical Properties (cont)

LTA	Landform	Dominant Bedrock	Relict Geomorphic Process	Active Geomorphic Process	Slope Gradient (%)	Volcanic Ash	Regolith Texture	Depth to Bedrock
568	Canyons	Metavolcanic, Metasedimentary, Serpentine	Tectonic Folding/Uplift/ Erosion	Fluvial, Mass Wasting, and Colluvial Erosion	60 to 90	n/a	n/a	0-1
600	WATER							
736	Basins, Fans, and Terraces	Undifferentiated	Undifferentiated/Eolian/ Fluvial-MassWasting	Mass Wasting/Fluvial Erosion and Deposition	15 to 50	no influence	moderately coarse to fine	10-20
832	Alpine Ridges	Undifferentiated	Glaciation/Glacial-Periglacial Erosion/Eolian	Mass Wasting and Colluvial Erosion	60 to 90	thick and mixed	moderately coarse to medium	<1-3

Soil Classification and Properties

Table 8 contains representative soils and their properties for each Landtype Association. Listed below is a description of the information contained in each column.

Soil Classification Series Name: This column lists soil series selected to represent soil characteristics of major extent in each Landtype Association. These soil series or soils with similar characteristics will represent two thirds or more of the area in most polygons of a Landtype Association. Soils or miscellaneous areas (e.g. rock outcrop) with contrasting characteristics, but of minor extent also occur in most map units. These are sometimes listed when known. The soil series list was developed from the National Cooperative Soil Survey (NCSS)/ Terrestrial Ecological Unit Inventory of the Blue Mountain National Forests (USDA Forest Service, in progress) for the Wallowa-Whitman, Umatilla, Malheur and Ochoco National Forests and the NCSS Baker County Soil Survey (USDA NRCS 1997). For more detailed information about soils distribution, refer to the Terrestrial Ecological Unit Inventory or Landtype inventory (TEUI). Several soils have yet to be classified to the series and are listed as undetermined.

Soil Taxonomic Subgroup and Great Group: These columns list the taxonomic subgroup and great group classification of the soils listed. Taxa are classified according to *Keys To Soil Taxonomy, tenth edition* (USDA Soil Survey Staff 2006). The presence, depth and disturbance of volcanic ash from historic volcanic eruptions are usually indicated by the taxa classification. Soil climate, thin soil mantles, and degree of soil development are also factors indicated by the taxa classification. For those who make the effort to learn this classification, it is a useful means of understanding basic differences in soil properties.

Soil Extent: This column contains an estimated proportionate extent of each representative soil. This percentage is a representation of the modal concept of soil occurrence within a Landtype Association. Proportionate extent of each soil will vary in different delineations of a map unit. The extent of a soil series and similar soils will be within twenty percent of the estimate, in most delineations; considered standard for LTA scale and intensity.

Volcanic Ash : This column lists five classes of volcanic ash mantle: thick mantle, thin mantle, mixed ash, minor ash, and no ash. Deposition and erosion processes have created a mosaic of undisturbed ash, ash redistributed and mixed with other colluvial or eolian materials, soil materials with only a minor influence of ash and materials devoid of volcanic ash. Distribution of volcanic ash serves as an index to erosion, deposition, fire frequency, cover by vegetation and litter, and general landscape stability. Thicker layers indicate more stable or depositional environments while thinner layers indicate erosional environments and possibly higher fire frequency. And, generally, distribution, depth, and purity are correlated with steepness of slope, slope position, and slope aspect. The greater purity and depths occur on north aspects and mid to higher elevation gentle slopes and support moist forest. Infrequently, great depths of volcanic ash can occur along toeslopes where either colluvial or alluvial processes have moved the ash after its initial deposit. Mounds of wind distributed volcanic ash occur frequently on backslopes of plateaus and less so on summits of plateaus. Mixed ash occurs on colluvial foot slopes, climatic zones

with more frequent fire and areas that receive significant loess deposition. Soil materials in flood plains and low terraces on valley floors are devoid of ash having been washed away in swift runoff.

The following classes define the amount or influence of volcanic ash for each soil.

- Ash mantles (>60 percent volcanic ash; >7 inches thick)
  - Thick (> 14 inches thick)
  - Thin (7-14 inches thick)
- Mixed ash (30-60 percent volcanic ash; >7 inches thick)
- Minor ash influence (5-30 percent volcanic ash; > 7 inches thick)
- No ash influence (0-5 percent volcanic ash)

Surface Texture: For the purpose of this interpretation, "surface" is the layer that commonly supports the root zone for fine and medium size roots. This column contains the Soil Textural Classes defined in the USDA Soil Survey Manual (USDA Soil Survey 1993), not to be confused with the particle-size class defined in Soil Taxonomy (USDA Soil Survey 1998). These textural classes are defined below.

Regolith Texture: Regolith texture is of the unconsolidated material from the base of the surface layer to a bedrock contact. Soils with an ash or loess mantle commonly have a different surface texture than in the material buried beneath the ash. Textures are grouped using the Soil Textural Classes defined in the USDA Soil Survey Manual (USDA Soil Survey 1993).

Soil Textural Classes are as follows:

coarse - sands and loamy sands

moderately coarse - sandy loams

medium - very fine sands, loams, silt loams, and silt

moderately fine - clay loams, sandy clay loams, and silty clay loams

fine- sandy clay, silty clay, and clay

Regolith Rock Fragments (Size and Percent Volume): This column contains the dominant shape and size of rock fragments as defined in the USDA Soil Survey Manual (USDA Soil Survey Staff 1993). *Gravelly* represents angular and spherical rock 2-75 mm diameter. *Cobbly* represents angular and spherical rock 75-250 mm. *Stony* represents angular and spherical rock greater than 250mm diameter. The amount of rock fragments is quite variable and ranges are given to indicate this variability and the general trend.

Depth to Bedrock: This column contains the depth of unconsolidated soil or surficial deposits to consolidated bedrock. This interpretation was based upon TEUI soil series descriptions and observations of representative soils in the field.

Parent Material: This column contains the dominant bedrock or type of surficial deposit influencing regolith properties.

Soil Climate: This column contains general soil temperature and moisture regimes. These regimes are based upon soil taxa and plant association groups.

Table 8. Soil Classification and Properties

MUS	Soil Series Name	Subgroup	Great Group	Soil Extent	Volcanic Ash	Surface Texture	Regolith Texture	Regolith Rock Fragments (size/%volume)	Depth to Bedrock	Parent Material	Soil Climate
114	Mountemily	Typic	Vitricryands	50	thick	medium	medium	cobbly 35 - 75	>10	basalt	Cold, Moist
	Limberjim	Alfic	Udivitrands	30	thick	medium	medium	cobbly 35 - 65	3-5	basalt	Cold, Moist
115	Mountemily	Typic	Vitricryands	50	thick	medium	medium	cobbly 35 - 75	10-20	basalt	Cold, Moist
	Limberjim	Alfic	Udivitrands	30	thick	medium	medium	cobbly 35 - 65	3-5	basalt	Cold, Moist
116	Limberjim	Alfic	Udivitrands	30	thick	medium	medium	cobbly 35 - 65	3-5	basalt	Cold, Moist
	Syrupcreek	Alfic	Udivitrands	25	thick	medium	medium	cobbly 35 - 65	2-3	basalt	Cold, Moist
	Mountemily	Typic	Vitricryands	15	thick	medium	medium	cobbly 35 - 75	10-20	basalt	Cold, Moist
	Troutmeadows	Typic	Vitricryands	10	thick	medium	moderately coarse	stony 40 - 75	2-3	basalt	Cold, Moist
117	Limberjim	Alfic	Udivitrands	30	thick	medium	medium	cobbly 35 - 65	3-5	basalt	Cold, Moist
	Mountemily	Typic	Vitricryands	20	thick	medium	medium	cobbly 35 - 75	>8	basalt	Cold, Moist
	Bennettcreek	Vitrandic	Haploxeralfs	15	mixed	medium	medium	gravelly 35 - 65	2-3	basalt	Cool, Somewhat dry
	Rebarrow	Alfic	Udivitrands	10	thick	medium	medium	stony 35 - 65	>8	basalt	Cold, Moist
	Syrupcreek	Alfic	Udivitrands	5	thick	medium	medium	cobbly 35 - 65	2-3	basalt	Cold, Moist
118	Harl	Typic	Udivitrands	30	thick	medium	medium	gravelly 35 - 65	>8	basalt	Cold, Moist
	Limberjim	Alfic	Udivitrands	25	thick	medium	medium	cobbly 35 - 65	3-5	basalt	Cool, Moist
	Larabee	Vitrandic	Argixerolls	15	mixed	medium	moderately fine	cobbly 35 - 65	2-3	basalt	Cool, Dry
	Bocker	Lithic	Haploxerolls	10	minor	medium	medium	gravelly 35 - 65	<1	basalt	Cool, Dry

Table 8. Soil Classification and Properties (cont)

MUS	Soil Series Name	Subgroup	Great Group	Soil Extent	Volcanic Ash	Surface Texture	Regolith Texture	Regolith Rock Fragments (size/%volume)	Depth to Bedrock	Parent Material	Soil Climate
124	Geisercreek	Alfic	Udivitrands	30	thick	medium	moderately fine	<35	>10	volcaniclastic deposits	Cool, Moist
	Btree	Alfic	Udivitrands	25	thick	medium	fine	cobbly 35 - 65	3-5	volcaniclastic deposits	Cool, Moist
	Ingrampoint	Alfic	Udivitrands	15	thick	medium	fine	cobbly 35 - 65	2-3	volcaniclastic deposits	Cool, Moist
	Olot, anss	Typic	Vitrixerands	10	thick	medium	moderately coarse	cobbly 35 - 65	2-3	volcaniclastic deposits	Cool, Somewhat dry
125	Geisercreek	Alfic	Udivitrands	40	thick	medium	moderately fine	<35	10-20	volcaniclastic deposits	Cool, Moist
	Btree	Alfic	Udivitrands	25	thick	medium	fine	cobbly 35 - 65	3-5	volcaniclastic deposits	Cool, Moist
	Ingrampoint	Alfic	Udivitrands	15	thick	medium	fine	cobbly 35 - 65	2-3	volcaniclastic deposits	Cool, Moist
126	Geisercreek	Alfic	Udivitrands	40	thick	medium	moderately fine	<35	10-20	volcaniclastic deposits	Cool, Moist
	Btree	Alfic	Udivitrands	25	thick	medium	fine	cobbly 35 - 65	3-5	volcaniclastic deposits	Cool, Moist
	Ingrampoint	Alfic	Udivitrands	15	thick	medium	fine	cobbly 35 - 65	2-3	volcaniclastic deposits	Cool, Moist
127	Ingrampoint	Alfic	Udivitrands	40	thick	medium	fine	cobbly 35 - 65	2-3	volcaniclastic deposits	Cool, Moist
	Btree	Alfic	Udivitrands	25	thick	medium	fine	cobbly 35 - 65	3-5	volcaniclastic deposits	Cool, Moist
	Lick	Alfic	Hapludalfs	15	thick	medium	moderately fine	gravelly 35 - 65	3-5	volcaniclastic deposits	Cool, Moist
131	Bucketlake	Typic	Vitricryands	30	thick	medium	moderately coarse	gravelly 35 - 65	10-20	glacial - undifferentiated	Cool, Moist
	Bulgar	Typic	Udivitrands	20	thick	medium	moderately coarse	cobbly 35 - 65	10-20	glacial - undifferentiated	Cool, Moist
	Mudlakebasin	Typic	Vitricryands	15	thick	medium	moderately coarse	gravelly 35 - 65	2-3	glacial - undifferentiated	Cool, Moist

Table 8. Soil Classification and Properties (cont)

MUS	Soil Series Name	Subgroup	Great Group	Soil Extent	Volcanic Ash	Surface Texture	Regolith Texture	Regolith Rock Fragments (size/%volume)	Depth to Bedrock	Parent Material	Soil Climate
131 (cont)	Ducklake	Typic	Vitricryands	10	thick	medium	moderately coarse	cobbly 35 - 65	3-5	glacial - undifferentiated	Cool, Moist
	Tyeecreek	Alfic	Vitricryands	5	thick	medium	moderately fine	gravelly 35 - 65	10-20	glacial - undifferentiated	Cool, Moist
132	Mudlakebasin	Typic	Vitricryands	50	thick	medium	moderately coarse	gravelly 35 - 65	2-3	glacial - undifferentiated	Cold, Moist
	Rock outcrop			30					0	glacial - undifferentiated	
133	Verdeplane	Pachic	Hapludolls	30	none	medium	moderately coarse	cobbly 15- 85	>20	Alluvium	Cool, Moist
	Digit	Typic	Vitricryands	25	thick	medium	moderately fine	<35	>20	Alluvium	Cold, Moist
	Bullroar	Typic	Udivitrands	15	thick	medium	moderately coarse	cobbly 35 - 65	>20	Alluvium	Cool, Moist
	Bigbouldercreek	Typic	Udivitrands	10	thick	medium	medium	<35	>20	Alluvium	Cool, Moist
135	Digit	Typic	Vitricryands	40	thick	medium	moderately fine	<35	10-20	Ashy colluvium	Cold, Moist
	Bodale	Pachic	Haplocryolls	25	none	medium	moderately coarse	gravelly 15 - 75	10-20	Ashy colluvium	Cold, Wet
	Bandarrow	Typic	Cryaquolls	15	none	medium	medium	<15	10-20	Ashy colluvium	Cold, Wet
144	Geisercreek	Alfic	Udivitrands	40	thick	medium	moderately fine	<35	>10	lacustrine deposition and burial by volcanic flows	Cool, Moist
	Btree	Alfic	Udivitrands	25	thick	medium	fine	cobbly 35 - 65	3-5	lacustrine deposition and burial by volcanic flows	Cool, Moist
	Lick	Alfic	Hapludalfs	15	thin	medium	moderately fine	gravelly 35 - 65	3-5	lacustrine deposition and burial by volcanic flows	Cool, Moist

Table 8. Soil Classification and Properties (cont)

MUS	Soil Series Name	Subgroup	Great Group	Soil Extent	Volcanic Ash	Surface Texture	Regolith Texture	Regolith Rock Fragments (size/%volume)	Depth to Bedrock	Parent Material	Soil Climate
146	Geisercreek	Alfic	Udivitrands	40	thick	medium	moderately fine	<35	>20	lacustrine deposition and burial by volcanic flows	Cool, Moist
	Limberjim	Alfic	Udivitrands	25	thick	medium	medium	cobbly 35 - 65	3-5	lacustrine deposition and burial by volcanic flows	Cool, Moist
	Btree	Alfic	Udivitrands	15	thick	medium	fine	cobbly 35 - 65	3-5	lacustrine deposition and burial by volcanic flows	Cool, Moist
155	Towermountain	Typic	Vitricryands	40	thick	medium	medium	cobbly 35 - 65	2-3	pyroclastic flows	Cold, Moist
	Gutridge, rtss	Typic	Udivitrands	25	thick	medium	medium	gravelly 35 - 65	3-5	pyroclastic flows	Cool, Moist
	Kingbolt, rtss	Typic	Vitrixerands	15	thick	medium	medium	gravelly 35 - 65	2-3	pyroclastic flows	Cool, Somewhat dry
156	Stalter, deep	Typic	Udivitrands	30	thick	medium	moderately coarse	gravelly 35 - 65	3-5	granodiorite	Cool, Moist
	Hoffer	Typic	Vitricryands	20	thick	medium	moderately coarse	<15	3-7	granodiorite	Cold, Moist
	Stalter	Typic	Udivitrands	15	thick	medium	moderately coarse	gravelly 35 - 65	2-3	granodiorite	Cool, Moist
	McCalpine-meadow	Typic	Vitricryands	10	thick	medium	moderately coarse	stony 40 - 75	2-3	granodiorite	Cold, Moist
	Angelpeak, rtss	Typic	Vitricryands	5	thick	medium	moderately coarse	gravelly 35 - 65	3-5	granodiorite	Very Cold, Moist
157	Ufish	Typic	Vitricryands	30	thick	medium	moderately coarse	stony 35 - 65	3-5	granodiorite	Cold, Moist
	Fourthcreek	Typic	Vitrixerands	25	thick	medium	moderately coarse	<35	2-3	granodiorite	Cool, Somewhat dry
	McCalpine-meadow	Typic	Vitricryands	15	thick	medium	moderately coarse	stony 40 - 75	2-3	granodiorite	Cold, Moist
	Reedmine	Typic	Udivitrands	10	thick	medium	moderately coarse	gravelly 35 - 65	3-5	granodiorite	Cool, moist

Table 8. Soil Classification and Properties (cont)

MUS	Soil Series Name	Subgroup	Great Group	Soil Extent	Volcanic Ash	Surface Texture	Regolith Texture	Regolith Rock Fragments (size/%volume)	Depth to Bedrock	Parent Material	Soil Climate
158	McCalpine-meadow	Typic	Vitricryands	30	thick	medium	moderately coarse	stony 40 - 75	2-3	granodiorite	Cold, Moist
	Prouty	Andic	Dystrocryepts	25	mixed	medium	moderately coarse	gravelly 35 - 65	2-3	granodiorite	Cold, Moist
	Rockcreekbutte	Haplo-xerandic	Humicryepts	15	minor	coarse	coarse	stony 35 - 65	2-3	granodiorite	Very Cold, Moist
	Ufish	Typic	Vitricryands	10	thick	medium	moderately coarse	stony 35 - 65	3-5	granodiorite	Cold, Moist
165	Towermountain, mvss	Typic	Vitricryands	30	thick	medium	medium	cobbly 35 - 65	2-3	metavolcanic and metasedimentary rocks	Cold, Moist
	Marblepoint, mvss	Andic	Haplocryepts	25	thin	medium	medium	cobbly 35 - 65	10-20	metavolcanic and metasedimentary rocks	Cold, Moist
	Angelpeak	Typic	Vitricryands	15	thick	medium	moderately coarse	gravelly 35 - 65	3-5	metavolcanic and metasedimentary rocks	Cold, Moist
	Bordengulch	Andic	Haplocryepts	10	thin	medium	moderately coarse	gravelly 35 - 65	2-3	metavolcanic and metasedimentary rocks	Cold, Moist
166	Bordengulch	Andic	Haplocryepts	40	thin	medium	moderately coarse	gravelly 35 - 65	2-3	metavolcanic and metasedimentary rocks	Cold, Moist
	Threecent	Typic	Udivitrands	25	thick	medium	medium	gravelly 40 - 70	2-3	metavolcanic and metasedimentary rocks	Cool, Moist
-	Analulu	Vitrandic	Haploxerepts	15	thin	medium	medium	gravelly 35 - 65	2-3	metavolcanic and metasedimentary rocks	Cool, Somewhat dry
167	Honeymooncan	Alfic	Udivitrands	25	thick	medium	moderately fine	gravelly 35 - 65	3-5	metavolcanic and metasedimentary rocks	Cool, Moist
	Twobit	Typic	Udivitrands	15	thick	medium	medium	cobbly 35 - 65	2-3	metavolcanic and metasedimentary rocks	Cool, Moist

Table 8. Soil Classification and Properties (cont)

MUS	Soil Series Name	Subgroup	Great Group	Soil Extent	Volcanic Ash	Surface Texture	Regolith Texture	Regolith Rock Fragments (size/%volume)	Depth to Bedrock	Parent Material	Soil Climate
167 (cont)	Pasturecreek	Andic	Eutrudepts	10	mixed	medium	moderately coarse	gravelly 35 - 80	>8	metavolcanic and metasedimentary rocks	Cool, Moist
168	Pasturecreek	Andic	Eutrudepts	30	mixed	medium	moderately coarse	gravelly 35 - 80	>8	metavolcanic and metasedimentary rocks	Cool, Moist
	Gutridge	Typic	Udivitrands	25	thick	medium	medium	gravelly 35 - 75	3-5	metavolcanic and metasedimentary rocks	Cool, Moist
	Twobit	Typic	Udivitrands	15	thick	medium	medium	cobbly 35 - 65	2-3	metavolcanic and metasedimentary rocks	Cool, Moist
	Honeymooncan	Alfic	Udivitrands	10	thick	medium	moderately fine	gravelly 35 - 65	3-5	metavolcanic and metasedimentary rocks	Cool, Moist
176	undetermined1*	Typic	Haploxerepts	30	minor	medium	medium	gravelly/ cobbly 30-50	1-2	metavolcanic and metasedimentary rocks	Cool, Dry
	undetermined2*	Vitrandic	Haploxerepts	25	mixed	medium	moderately fine	gravelly/ cobbly 30-50	1.5-3	metavolcanic and metasedimentary rocks	Cool, Dry
	undetermined3*	Lithic	Haploxerepts	30	minor	medium	medium	gravelly/ cobbly 45-70	<1	metavolcanic and metasedimentary rocks	Cool, Dry
177	undetermined4*	Typic	Udivitrands (Vitrandepts)	40	thick	medium	moderately fine	gravelly/ cobbly 30-50	2-3	metavolcanic and metasedimentary rocks	Cool, Moist
	undetermined3*	Lithic	Haploxerepts	25	minor	medium	medium	gravelly/ cobbly 45-70	<1	metavolcanic and metasedimentary rocks	Cool, Dry
	undetermined5*	Typic	Vitricryands	15	thick	medium	medium	gravelly/ cobbly 45-70	2-3	metavolcanic and metasedimentary rocks	Cold, Moist
214	Fourcorner, bss	Vertic	Palexerolls	50	minor	fine	fine	<15	3-5	basalt	Cool, Dry
	Cougarrock, bss	Vitrandic	Haploxeralfs	30	mixed	medium	moderately fine	gravelly 35 - 65	2-3	basalt	Cool, Somewhat dry

Table 8. Soil Classification and Properties (cont)

MUS	Soil Series Name	Subgroup	Great Group	Soil Extent	Volcanic Ash	Surface Texture	Regolith Texture	Regolith Rock Fragments (size/%volume)	Depth to Bedrock	Parent Material	Soil Climate
215	Klicker	Vitrandic	Argixerolls	50	minor	medium	moderately fine	gravelly 35 - 65	2-3	basalt	Cool, Dry
	Larabee	Vitrandic	Argixerolls	30	mixed	medium	moderately fine	cobbly 35 - 65	2-3	basalt	Cool, Dry
216	Larabee	Vitrandic	Argixerolls	40	mixed	medium	moderately fine	cobbly 35 - 65	2-3	basalt	Cool, Dry
	Bennettcreek	Vitrandic	Haploxeralfs	25	mixed	medium	medium	gravelly 35 - 65	2-3	basalt	Cool, Dry
	Wonder	Vitrandic	Haploxerepts	15	thin	medium	medium	stony 35 - 65	2-3	basalt	Cool, Somewhat dry
217	Klickson	Vitrandic	Argixerolls	40	mixed	medium	moderately fine	cobbly 35 - 80	3-5	basalt	Cool, Dry
	Larabee	Vitrandic	Argixerolls	25	mixed	medium	moderately fine	cobbly 35 - 65	2-3	basalt	Cool, Dry
	Bigcow	Vitrandic	Haploxerepts	15	thin	medium	medium	gravelly 35 - 65	3-7	basalt	Cool, Somewhat dry
218	Klicker	Vitrandic	Argixerolls	30	minor	medium	moderately fine	gravelly 35 - 65	2-3	basalt	Cool, Dry
0	Fivebit	Lithic Ultic	Haploxerolls	20	minor	medium	medium	gravelly 35 - 70	0.8-2	basalt	Cool, Dry
	Klickson	Vitrandic	Argixerolls	15	mixed	medium	moderately fine	cobbly 35 - 80	3-5	basalt	Cool, Dry
	Anatone	Lithic	Haploxerolls	10	minor	medium	medium	gravelly 35 - 85	0.8-2	basalt	Cool, Dry
	Larabee	Vitrandic	Argixerolls	5	mixed	medium	moderately fine	cobbly 35 - 65	2-3	basalt	Cool, Dry
224	Cleymor	Vertic	Argixerolls	40	minor	moderately fine	fine	<15	>10	metavolcanic and metasedimentary rocks	Cool, Dry
	Unity	Vertic	Palexeralfs	25	thin	medium	fine	<15	>10	metavolcanic and metasedimentary rocks	Cool, Dry

Table 8. Soil Classification and Properties (cont)

MUS	Soil Series Name	Subgroup	Great Group	Soil Extent	Volcanic Ash	Surface Texture	Regolith Texture	Regolith Rock Fragments (size/%volume)	Depth to Bedrock	Parent Material	Soil Climate
224 (cont)	Oxbone	Vitrandic	Haploxeralfs	15	mixed	medium	moderately fine	<15	3-5	metavolcanic and metasedimentary rocks	Cool, Somewhat dry
226	Cotay	Vitrandic	Haploxeralfs	30	mixed	medium	moderately fine	cobbly 35 - 80	2-3	metavolcanic and metasedimentary rocks	Cool, Somewhat dry
	Oxbone	Vitrandic	Haploxeralfs	20	mixed	medium	moderately fine	<15	3-5	metavolcanic and metasedimentary rocks	Cool, Somewhat dry
	Cougarrock	Vitrandic	Haploxeralfs	15	mixed	medium	moderately fine	gravelly 35 - 70	2-3	metavolcanic and metasedimentary rocks	Cool, Somewhat dry
	Humarel	Vitrandic	Argixerolls	10	minor	mod-erately fine	fine	gravelly 35 - 65	2-3	metavolcanic and metasedimentary rocks	Cool, Somewhat dry
	Kingbolt	Typic	Vitrixerands	5	thick	medium	medium	gravelly 35 - 65	2-3	metavolcanic and metasedimentary rocks	Cool, Somewhat dry
227	Cougarrock	Vitrandic	Haploxeralfs	50	mixed	medium	moderately fine	gravelly 35 - 70	2-3	volcaniclastic deposits	Cool, Somewhat dry
	Humarel	Vitrandic	Argixerolls	30	minor	moderately fine	fine	gravelly 35 - 65	2-3	volcaniclastic deposits	Cool, Somewhat dry
231	Bigelk	Vitrandic	Haploxerolls	30	minor	moderately coarse	moderately coarse	stony 35 - 65	10-20	glacial - undifferentiated	Cool, Somewhat dry
	Lakefork	Typic	Udivitrands	25	thick	medium	medium	stony 45 - 80	10-20	glacial - undifferentiated	Cool, Moist
	Warfield	Vitrandic	Haploxerepts	15	mixed	moderately coarse	moderately coarse	stony 50 - 80	3-5	glacial - undifferentiated	Cool, Somewhat dry
	Twocolor	Typic	Vitrixerands	10	thick	medium	moderately coarse	stony 35 - 65	10-20	glacial - undifferentiated	Cool, Somewhat dry
232	Lakefork	Typic	Udivitrands	40	thick	medium	moderately coarse	stony 45 - 80	>8	glacial - undifferentiated	Cool, Moist

Table 8. Soil Classification and Properties (cont)

MUS	Soil Series Name	Subgroup	Great Group	Soil Extent	Volcanic Ash	Surface Texture	Regolith Texture	Regolith Rock Fragments (size/%volume)	Depth to Bedrock	Parent Material	Soil Climate
232 (cont)	Rock outcrop			25					0	glacial - undifferentiated	
	Moodybasin	Vitrixerandic	Humicryepts	15	minor	moderately coarse	moderately coarse	stony 55 - 75	2-3	glacial - undifferentiated	Very Cold, Moist
233	Stevenscreek	Vitrandic	Haploxeralfs	40	minor	moderately fine	moderately fine	cobbly 45 – 60	>20	alluvium	Cool, Dry
	Ranes	Vitrandic	Haploxeralfs	40	thin	medium	medium	cobbly 35 - 65	>20	alluvium	Cool, Dry
235	Langrell	Pachic	Haploxerolls	50	none	medium	medium	gravelly 35 - 65	>8	colluvium/ alluvium	Cool, Dry
	Stevenscreek	Vitrandic	Haploxeralfs	30	minor	moderately fine	moderately fine	cobbly 45 - 60	>8	colluvium/ alluvium	Cool, Dry
236	Stevenscreek	Vitrandic	Haploxeralfs	50	minor	moderately fine	moderately fine	cobbly 45 - 60	>20	alluvium	Cool, Dry
	Ranes	Vitrandic	Haploxeralfs	30	thin	medium	medium	cobbly 35 - 65	>20	alluvium	Cool, Dry
244	Volstead	Vitrandic	Argixerolls	40	mixed	medium	moderately fine	<15	3-5	lacustrine deposition with volcanic burial	Cool, Dry
	Quirk	Vitrandic	Palexerolls	25	mixed	medium	fine	<35	2-3	lacustrine deposition with volcanic burial	Cool, Dry
	Tamarackcanyon	Vitrandic	Haploxeralfs	15	mixed	moderately fine	fine	cobbly 35 - 65	2-3	lacustrine deposition with volcanic burial	Cool, Dry
246	Quirk	Vitrandic	Palexerolls	50	mixed	medium	fine	<35	2-3	lacustrine deposition and burial by volcanic flows	Cool, Dry
	Klicker	Vitrandic	Argixerolls	30	minor	medium	moderately fine	gravelly 35 - 65	2-3	lacustrine deposition and burial by volcanic flows	Cool, Dry
256	Kingbolt, rtss	Typic	Vitrixerands	50	thick	medium	medium	gravelly 35 - 65	2-3	pyroclastic flows	Cool, Somewhat dry

Table 8. Soil Classification and Properties (cont)

MUS	Soil Series Name	Subgroup	Great Group	Soil Extent	Volcanic Ash	Surface Texture	Regolith Texture	Regolith Rock Fragments (size/%volume)	Depth to Bedrock	Parent Material	Soil Climate
256 (cont)	Eastpine, rtss	Vitrandic Ultic	Haploxerolls	30	mixed	medium	medium	cobbly 35 - 65	2-3	pyroclastic flows	Cool, Somewhat dry
257	McWillar	Alfic	Vitrixerands	40	thick	medium	moderately fine	gravelly 35 - 65	3-5	pyroclastic flows	Cool, Somewhat dry
	Analulu, rtss	Vitrandic	Haploxerepts	25	minor	moderately coarse	medium	gravelly 35 - 65	2-3	pyroclastic flows	Cool, Dry
	Threecabin, rtss	Vitrandic	Haploxerepts	15	minor	medium	medium	gravelly 35 - 65	3-5	pyroclastic flows	Cool, Somewhat dry
258	Threecabin, rtss	Vitrandic	Haploxerepts	50	minor	medium	medium	gravelly 35 - 65	3-5	pyroclastic flows	Cool, Somewhat dry
	Analulu, rtss	Vitrandic	Haploxerepts	30	minor	moderately coarse	medium	gravelly 35 - 65	2-3	pyroclastic flows	Cool, Dry
265	Hondu, mvss	Vitrandic	Haploxerepts	50	thin	medium	moderately coarse	gravelly 35 - 65	10-20	metavolcanic and metasedimentary rocks	Cool, Somewhat dry
	Deck	Vitrandic	Haploxerolls	30	minor	medium	moderately coarse	cobbly 35 - 65	2-3	metavolcanic and metasedimentary rocks	Cool, Somewhat dry
266	Deck	Vitrandic	Haploxerolls	50	mixed	medium	moderately fine	<15	2-3	metavolcanic and metasedimentary rocks	Cool, Dry
	Eastlakes	Lithic	Humicryepts	30	minor	medium	medium	gravelly 50 - 70	0.8-2	metavolcanic and metasedimentary rocks	Cold, Dry
267	Analulu	Vitrandic	Haploxerepts	40	thin	medium	medium	gravelly 35 - 65	2-3	metavolcanic and metasedimentary rocks	Cool, Somewhat dry
	Kettlecreek	Vitrandic	Haploxerolls	25	mixed	moderately coarse	moderately coarse	gravelly 55 - 85	3-5	metavolcanic and metasedimentary rocks	Cool, Dry
	Payraise	Vitrandic	Haploxeralfs	15	thin	medium	moderately coarse	stony 35 - 65	>8	metavolcanic and metasedimentary rocks	Cool, Somewhat dry

Table 8. Soil Classification and Properties (cont)

MUS	Soil Series Name	Subgroup	Great Group	Soil Extent	Volcanic Ash	Surface Texture	Regolith Texture	Regolith Rock Fragments (size/%volume)	Depth to Bedrock	Parent Material	Soil Climate
268	Analulu	Vitrandic	Haploxerepts	40	thin	medium	medium	gravelly 35 - 65	2-3	metavolcanic and metasedimentary rocks	Cool, Somewhat dry
	Rock outcrop			25					0	metavolcanic and metasedimentary rocks	
	Blackgulch	Lithic Ultic	Haploxerolls	15	minor	medium	medium	cobbly 35 - 65	0.8-2	metavolcanic and metasedimentary rocks	Cool, Dry
273	undetermined2*	Vitrandic	Haploxerepts	35	mixed	medium	moderately fine	gravelly/ cobbly 30-50	1.5-3	Alluvium: Sedimentary - graywacke	Cool, Dry
	undetermined6*	Lithic Ultic	Argixerolls	25	none	medium	medium	gravelly/ cobbly 20-60	<1	Alluvium: Sedimentary - graywacke	Cool, Dry
	undetermined3*	Lithic	Haploxerepts	20	minor	medium	medium	gravelly/ cobbly 45-70	<1	Alluvium: Sedimentary - graywacke	Cool, Dry
275	undetermined1	Typic	Haploxerepts	60	minor	medium	medium	gravelly/ cobbly 30-50	1-2	Sedimentary – greywacke, shales	Cool, Dry
	undetermined3*	Lithic	Haploxerepts	25	minor	medium	medium	gravelly/ cobbly 45-70	<1	Sedimentary – greywacke, shales	Cool, Dry
276	undetermined1	Typic	Haploxerepts	35	minor	medium	medium	gravelly/ cobbly 30-50	1-2	Sedimentary – greywacke, shales	Cool, Dry
	undetermined3*	Lithic	Haploxerepts	20	minor	medium	medium	gravelly/ cobbly 45-70	<1	Sedimentary – greywacke, shales	Cool, Dry
277	undetermined2*	Vitrandic	Haploxerepts	30	mixed	medium	moderately fine	gravelly/ cobbly 30-50	1.5-3	Sedimentary – greywacke, shales	Cool, Dry
	undetermined3*	Lithic	Haploxerepts	20	minor	medium	medium	gravelly/ cobbly 45-70	<1	Sedimentary – greywacke, shales	Cool, Dry

Table 8. Soil Classification and Properties (cont)

MUS	Soil Series Name	Subgroup	Great Group	Soil Extent	Volcanic Ash	Surface Texture	Regolith Texture	Regolith Rock Fragments (size/%volume)	Depth to Bedrock	Parent Material	Soil Climate
315	Clearline	Vitrandic	Haploxerolls	50	mixed	medium	moderately coarse	cobbly 40 - 75	3-5	Basalt	Cool, Dry
	Imnaha	Vitrandic	Argixerolls	30	mixed	medium	medium	gravelly 35 - 75	2-3	Basalt	Cool, Dry
316	Anatone	Lithic	Haploxerolls	50	minor	medium	medium	gravelly 35 - 85	0.8-2	Basalt	Cool, Dry
	Bocker	Lithic	Haploxerolls	30	minor	medium	medium	gravelly 35 - 65	<1	Basalt	Cool, Dry
317	Anatone	Lithic	Haploxerolls	30	minor	medium	medium	gravelly 35 - 85	0.8-2	Basalt	Cool, Dry
	Imnaha	Vitrandic	Argixerolls	25	mixed	medium	medium	gravelly 35 - 75	2-3	Basalt	Cool, Dry
	Rock outcrop			15					0	Basalt	
	Bocker	Lithic	Haploxerolls	10	minor	medium	medium	gravelly 35 - 65	<1	Basalt	Cool, Dry
318	Anatone	Lithic	Haploxerolls	30	minor	medium	medium	gravelly 35 - 85	0.8-2	Basalt	Cool, Dry
	Rock outcrop			25					0	Basalt	
	Bocker	Lithic	Haploxerolls	15	minor	medium	medium	gravelly 35 - 65	<1	Basalt	Cool, Dry
	Imnaha	Vitrandic	Argixerolls	10	mixed	medium	medium	gravelly 35 - 75	2-3	Basalt	Cool, Dry
326	Roostercomb	Typic	Argixerolls	50	minor	moderately fine	fine	cobbly 35 - 65	2-3	volcaniclastic deposits	Cool, Dry
	Ateron	Lithic	Argixerolls	30	minor	medium	fine	cobbly 35 – 65	0.8-2	volcaniclastic deposits	Cool, Dry
327	Hafmau	Lithic Ultic	Argixerolls	50	minor	moderately coarse	fine	cobbly 35 - 85	0.8-2	volcaniclastic deposits	Cool, Dry
	Harlow	Lithic	Argixerolls	30	minor	medium	fine	cobbly 35 - 65	0.8-2	volcaniclastic deposits	Cool, Dry
332	Rock outcrop			40					0	glacial - undifferentiated	
	Moodybasin	Vitrixerandic	Humicryepts	25	minor	moderately coarse	moderately coarse	stony 55 - 75	2-3	glacial - undifferentiated	Cold, Dry

Table 8. Soil Classification and Properties (cont)

MUS	Soil Series Name	Subgroup	Great Group	Soil Extent	Volcanic Ash	Surface Texture	Regolith Texture	Regolith Rock Fragments (size/%volume)	Depth to Bedrock	Parent Material	Soil Climate
332 (cont)	Muddycreek	Andic	Humicryepts	15	minor	coarse	coarse	stony 35 - 80	>8	glacial - undifferentiated	Cold, Moist
333	Phys	Typic	Argixerolls	40	minor	medium	moderately fine	cobbly 35 - 65	>20	alluvium	Cool, Dry
	Campcreek	Vertic	Palexerolls	25	minor	medium	fine	<35	>20	alluvium	Cool, Dry
	Lizard	Typic	Palexerolls	15	minor	medium	fine	gravelly 35 - 65	>20	alluvium	Cool, Dry
356	Wintercanyon, rtss	Lithic Ultic	Haploxerolls	40	minor	medium	medium	gravelly 35 - 75	0.8-2	pyroclastic flows and igneous intrusive with uplift	Cool, Dry
	VanPatten	Lithic	Humicryepts	25	minor	moderately coarse	moderately coarse	gravelly 35 - 65	0.8-2	pyroclastic flows and igneous intrusive with uplift	Cool, Dry
	Van Wagoner	Lithic	Haploxerolls	15	minor	moderately coarse	moderately coarse	cobbly 35 - 65	0.8-2	pyroclastic flows and igneous intrusive with uplift	Cool, Dry
357	VanPatten	Lithic	Humicryepts	50	minor	moderately coarse	moderately coarse	stony 35 - 65	0.8-2	pyroclastic flows and igneous intrusive with uplift	Cool, Dry
	Van Wagoner	Lithic	Haploxerolls	30	minor	moderately coarse	moderately coarse	cobbly 35 - 65	0.8-2	pyroclastic flows and igneous intrusive with uplift	Cool, Dry
358	Rock outcrop			50					0	pyroclastic flows and igneous intrusive with uplift	
	Powderriver	Lithic	Haploxerepts	30	minor	moderately coarse	moderately coarse	gravelly 35 - 65	0.8-2	pyroclastic flows and igneous intrusive with uplift	Cool, Dry
365	Bluecanyon, mvss	Lithic	Haploxerolls	80	minor	medium	medium	gravelly 35 - 65	0.8-2	metavolcanic and metasedimentary rocks	Cool, Dry
366	Bluecanyon	Lithic	Haploxerolls	50	minor	medium	medium	gravelly 45 - 75	0.8-2	metavolcanic and metasedimentary rocks	Cool, Dry
	Analulu	Vitrandic	Haploxerepts	30	minor	moderately coarse	medium	gravelly 35 - 75	2-3	metavolcanic and metasedimentary rocks	Cool, Dry

Table 8. Soil Classification and Properties (cont)

MUS	Soil Series Name	Subgroup	Great Group	Soil Extent	Volcanic Ash	Surface Texture	Regolith Texture	Regolith Rock Fragments (size/%volume)	Depth to Bedrock	Parent Material	Soil Climate
367	Hondu	Vitrandic	Haploxeralfs	50	thin	medium	moderately coarse	gravelly 35 - 65	3-5	metavolcanic and metasedimentary rocks	Cool, Somewhat dry
	Mcwillar	Alfic	Vitrixerands	30	thick	medium	moderately coarse	gravelly 35 - 65	3-5	metavolcanic and metasedimentary rocks	Cool, Somewhat dry
368	Blackgulch	Lithic Ultic	Haploxerolls	80	minor	medium	medium	cobbly 35 - 65	0.8-2	metavolcanic and metasedimentary rocks	Cool, Dry
376	undetermined3*	Lithic	Haploxerepts	70	minor	medium	medium	gravelly/ cobbly 45-70	<1	Sedimentary – greywacke, shales	Cool, Dry
377	undetermined3*	Lithic	Haploxerepts	70	minor	medium	medium	gravelly/ cobbly 45-70	<1	Sedimentary – greywacke, shales	Cool, Dry
416	Albee	Vitrandic	Haploxerolls	50	mixed	medium	medium	<35	2-3	Basalt	Cool, Dry
	Needhill	Vitrandic	Argixerolls	30	mixed	medium	medium	cobbly 35 – 65	3-5	Basalt	Cool, Dry
418	Cherrycreek	Vitrandic	Haploxerolls	50	mixed	medium	medium	cobbly 35 - 65	3-5	Basalt	Cool, Dry
	Anatone, north	Lithic	Haploxerolls	30	minor	medium	medium	gravelly 35 - 65	0.8-2	Basalt	Cool, Dry
432	Burgerbutte	Lithic	Humicryepts	50	minor	medium	medium	gravelly 60 - 75	0.8-2	glacial - undifferentiated	Cold, Moist
	Rock outcrop			30					0	glacial - undifferentiated	
433	Witknee	Aquic	Hapludolls	80	none	moderately coarse	moderately coarse	gravelly 25-60	>20	alluvium	Cool, Seasonally wet
468	Analulu	Vitrandic	Haploxerepts	55	thin	medium	medium	gravelly 35 - 65	2-3	metavolcanic and metasedimentary rocks	
	Rock outcrop			20							
518	Rock outcrop			80					0	Basalt	
532	Rock outcrop			80					0	glacial - undifferentiated	

Table 8. Soil Classification and Properties (cont)

MUS	Soil Series Name	Subgroup	Great Group	Soil Extent	Volcanic Ash	Surface Texture	Regolith Texture	Regolith Rock Fragments (size/%volume)	Depth to Bedrock	Parent Material	Soil Climate
558	Rock outcrop			80					0	pyroclastic flows and igneous intrusive with uplift	
567	Rock outcrop			80					0	metavolcanic and metasedimentary rocks	
568	Rock outcrop			80					0	metavolcanic and metasedimentary rocks	
600	WATER										
736	Riceton	Pachic Ultic	Haploxerolls	70	none	moderately coarse	moderately coarse	<35	10-20	alluvium	Cool, Dry
	Damore	Fluv-aquentic	Haploxerolls	15	none	medium	medium	gravelly 35 - 65	>8	alluvium	Cool, Wet
	Melloe	Typic	Endaquolls	15	none	medium	moderately fine	cobbly 40 - 80	10-20	alluvium	Cool, Wet
832	Moodybasin	Vitrixerandic	Humicryepts	30	minor	moderately coarse	moderately coarse	stony 55 - 75	2-3	alluvium	Cool, Moist
	Rock outcrop			25						alluvium	
	Burgerbutte	Lithic	Humicryepts	20	minor	medium	medium	gravelly 60 - 75	0.8-2	alluvium	Cold, Moist

Hydrologic Properties and Responses

Table 9 contains hydrologic properties, features, classifications, and major channel processes for each Landtype Association. Listed below is a brief description of the information contained in each column of the table.

Surface Runoff: This column contains the interpretation for relative response time for runoff from snowpack melt or high intensity rainstorms to become concentrated flow in first order streams. This interpretation is an indication of the ability or inability of Landtype Association to absorb and route surface water. The site factors used to develop this interpretation include: slope gradient; vegetation cover, soil regolith texture and rock fragment content; amount of exposed bedrock; density and type of first order drainages; amount, form and timing of precipitation, and stream patterns.

SLOW - Landtype Associations can absorb a great deal of surface water and runoff normally is well regulated and does not become concentrated in first order streams. Landtype Association features limit surface water from being routed quickly to first order stream systems. First order stream channels do not have evidence of scour or non-vegetated deposition. Normally these Landtype Associations have not had a history of shallow rapid landslides. Usually Landtype Associations have a set of the following site features: low slope gradients <25%, more than 80 percent vegetation cover; deep, coarse textured regolith; very little exposed bedrock; low drainage density of confined or entrenched first order streams; area not normally exposed to rain on snow events or high intensity thunder storms.

MODERATE - Landtype Associations absorb some surface water and runoff is somewhat well regulated but concentrated flows routed into first order drainages from infrequently large storms or snowmelt have the potential for high peak runoff flows. Landtype Association features are somewhat efficient in routing surface water into first order stream systems. First order stream channels have some evidence of scour. Normally these Landtype Associations have had an infrequent history of high peak runoff events that cause road drainage failures or rapid sediment transport. Usually Landtype Associations have a set of the following site features: slope gradients between 25 and 45 percent; vegetation cover is 30 to 80 percent; regolith depths that vary from shallow to moderately deep; exposed bedrock is less than 25 percent of the area; moderate drainage density of confined or entrenched first order stream systems; area exposed to infrequent rain on snow events or high intensity summer storms.

FLASHY - Landtype Associations do not absorb a great deal of surface water, runoff is poorly regulated and concentrated flows are routed rapidly into first order drainages. Landtype Association features are extremely efficient in routing surface water into first order stream systems. First order stream channels have evidence of scour or non-vegetated deposition. Normally these Landtype Associations have had a relatively frequent history of shallow rapid landslides or snow avalanche. Usually Landtype Associations have a set of the following site features: steep slope gradients (45%+); less than 30 percent vegetation cover; shallow regolith; exposed bedrock exceeds 25 percent of the area; high drainage density of confined or entrenched first order streams; area is exposed to frequent rain on snow events or high intensity summer storms.

Channel Density: This column rates the average number of channels per lineal mile. A channel is defined as any fluvial feature whether it has annual flow or not. Channels may be 0 order in class with ephemeral flow or higher order in class with perennial flow. The measure is lineal distance perpendicular to the slope gradient (except for stream valleys where both perpendicular and parallel lineal distance is considered to take into account the mainstem and tributaries of a stream valley landform). This measure is useful in predicting drainage crossings for roads and with other landform features, sediment delivery efficiency.

Low: 1-3 channels per mile

Moderate: 3-6 channels per mile

High: 6 channels per mile

Stream Flow Duration/Amount: The next two columns describe stream flow duration and amount for mainstem streams. Duration is noted as either perennial or intermittent and amount is the degree of flow expected during the summer months. This interpretation was based upon field observations of stream flows, Soil Resource Inventory descriptions, and extrapolation from other areas with similar landtype features.

Aquifer Recharge: This column describes the potential for near surface ground water storage within each Landtype Association. This interpretation is an indication of the ability of Landtype Associations to regulate stream flows especially late into the season. It can also help indicate the Landtype Associations that have shallow aquifers that contribute to stream flow recharge and temperature moderation. Factors used to develop this interpretation include: soil regolith depth and texture; landform shape, slope exposures and gradient; geologic fracturing and structure; annual precipitation; and surface drainage configuration.

LOW (L) - Landtype Associations have little storage capacity for near surface ground water. Shallow aquifers are limited and recharge to stream flow is very low. Summer stream flows are often intermittent or flows are unusually low in comparison to watershed size. Low aquifer recharge of summer stream flows may be a factor in elevated stream temperatures. Surface water is concentrated and routed quickly to stream systems causing elevated spring peaks. Few seeps and springs are present. Usually Landtype Associations have a set of the following site features: very shallow regolith over bedrock; landform shape, slope gradient and drainage systems that route surface and subsurface water rapidly to larger order streams; geologic features (faults, fractures, and folds) route subsurface water into deep aquifers or the lack of these features cause subsurface water to be routed quickly to drainage systems; or areas without potential for water table retention that receive low annual precipitation much of which is in the form of rain.

MODERATE (M) - Landtype Associations have storage capacity for near surface ground water but recharge of the aquifer is highly variable which influences recharge to stream flow. Summer stream flows are usually perennial or intermittent but stream flows are variable. Aquifer recharge may not be enough to modify summer or winter stream temperatures in all stream systems. Surface water has the ability to be absorbed and stored for recharge of stream flows but normally not enough to fully charge these shallow

aquifers annually. Seeps and springs are present. Usually Landtype Associations have a set of the following site features: soil regolith depth is variable but often moderately deep; landform shape, slope gradient, and drainage systems route surface and subsurface water slowly to larger order streams; geologic features restrict downward movement of groundwater; receive little drainage water from upslope landforms; and areas receive moderate amounts of annual precipitation of which there is an equal amount in the form of rain and snow.

HIGH (H) - Landtype Associations have significant storage capacity for near surface ground water. Shallow aquifers exist and directly recharge to stream flow. Summer stream flows are typically perennial and stream flows are high in comparison to other drainage systems. Aquifer recharge of stream flows may help moderate summer and winter stream temperatures. Surface water has the ability to be absorbed and stored for recharge of summer stream flows. Seeps and springs are a common feature. Usually Landtype Associations have a set of the following site features: very deep coarse textured regoliths; landform shape, slope gradient, and drainage systems that route surface and subsurface water slowly to larger order streams; geologic features restrict the downward movement of groundwater; receive a tremendous amount of drainage water from upslope landforms; and areas receive high amount of annual precipitation much of which is in the form of snow.

<u>Stream Types</u>: This column contains the dominant stream types based upon a classification system documented in Rosgen (1994). Rosgen's classification provides a morphological description of the channel using stream gradient, width:depth ratio, substrate size, channel confinement, and near channel landform stability. This classification is useful in broad assessments, monitoring condition, and in setting stream restoration objectives. Each Landtype Association was evaluated to determine the predominant morphologic type based upon field observations and empirically using aerial photography.

Aa *Stream Types*- Streams that have extremely steep gradients and are deeply entrenched. They are most often associated with stream segments in the upper elevation zones of high relief landforms formed from glacial erosion and over-steepening. Most common channel morphology is debris chutes, vertical steps, with shallow scour pools, and waterfalls. Most common stream reach types are bedrock and colluvial.

A Stream Types - Streams that have steep gradients and are normally entrenched. Most often associated with stream segments in the mid to upper elevation zones of high relief landforms formed from glacial or fluvial erosional processes. Most common stream reach type is cascade and step pool.

B Stream Types - Streams that have moderate gradients and entrenchment. Most often associated with stream segments in the mid elevation zones of high relief landforms formed from glacial or fluvial erosional processes. Most common stream reach type is step pool and forced step pool.

C Stream Types - Streams that have low gradients and are unconfined from valley walls. Width depth ratios are high. These are alluvial channels with broad well defined flood plains. Most often associated with stream segments in the lower

elevation zones of low relief landforms formed from glacial or fluvial depositional processes. Most common stream reach type is pool riffle channels.

D Stream Types - Streams that have braided channels associated with high bedload deposition. Most often associated with stream segments in lower elevation zones of low relief landforms formed from glacial or fluvial deposition (outwash). Most common stream reach type is braided channels.

E Stream Types - Streams that have low gradients and are unconfined from valley walls. Streams are highly sinuous with finer textured banks and little channel roughness. Width depth ratios are low. Most often associated with stream segments in the lower elevation zones of low relief landforms formed from glacial or fluvial depositional processes. Most common stream reach type is plane bed channels.

F Stream Types - Streams that have low gradients and are entrenched. Width depth ratios are high. These are streams that have entrenched meandering channels which are in the process of reestablishing a functional floodplain. Most often associated with dynamic change of discharge power. Most common stream reach type is plane bed and pool riffle channels.

G Stream Types - Streams that have moderate to steep gradients and are entrenched. These streams are usually associated with gullies from erosional events. Width depth ratios are very low. Most common stream reach type is plane bed and step pool channels.

<u>Stream Reach Processes</u>: This column contains the dominant channel processes based upon a classification system documented in Montgomery and Buffington (1993). This classification system describes stream bed morphology, sediment transport processes, and sediment flux characteristics as controlled by hydraulic discharge and sediment supply. Channel response is also described based on stream confinement, debris flow impacts, and large woody debris loading and is useful for interpretation of channel response to changes in sediment, wood, and discharge within a stream network. Channel types for each Landtype Association were identified based upon field experience and aerial photo interpretation and extrapolated using general geomorphic characteristics associated with landtype associations. The identification of channel types provides a first step for assessing potential channel responses to increases or decreases in discharge and in-channel sediment (Montgomery and Buffington 1993). According to Montgomery and Buffington: *"The spatial distribution of source, transport, and response reaches governs the distribution of potential impacts and watershed recovery time. General response for source, transport, and response reaches define patters of sensitivity to altered discharge, sediment supply, or debris flow scour within a watershed".*

SOURCE - Source reaches are transport-limited channels that allow for sediment storage. The most common channel type is *colluvial* channels. These channels fill with colluvial deposition from hillslopes, upslope hollows or catchment basins. Increased sediment storage may result in large downslope deliveries of sediment during major channel scouring events. High discharge may mobilize streambeds, scour streambeds or cause debris flows which transports sediment downstream. In time, these scoured channels begin to refill with sediment. This action is intermittent or episodic with various

frequencies depending on hydrologic regimes. In steep, upper elevations, colluvial channels are very active and are not stable enough to store sediment for extended periods of time.

TRANSPORT - Transport reaches are resilient, high gradient channels that are capable of rapidly conveying increased sediment inputs. The most common channel types are bedrock, cascade, and step pool.

Bedrock channels are confined by exposed bedrock, channel width and channel depth will increase to handle increased discharge. Moderate changes in discharge or sediment load are rapidly transmitted downstream without significant morphological changes within these reaches.

Cascade channels generally have well armored immobile boulders and are laterally confined by valley walls. Channel bank cutting or down-cutting are unlikely responses to changes in sediment supply or discharge. These types of confined channels can also respond to increased discharge by simple flow expansion. Because of their position within the network, cascade channels typically are subject to debris flow impacts. However, in-channel sediment loading from debris slides is often short lived and easily flushed downstream. Significant morphological changes within these reaches are not expected with normal sediment input from debris slides.

Step pool channels are confined channels with series of cascades and small pools. High transport capacities enable increased discharges or sediment loads to be transmitted downstream. As with other confined channels, increased discharge may result in flow width and height expansion without bank cutting or channel down-cutting. However, changes in pool depth, and thus channel storage are significant morphological changes. Usually these changes in pool depth are temporary and associated with a decline in the frequency and duration of pool scouring flows or large increases in sediment. Channel morphology is generally re-established after flood events.

RESPONSE - Response reaches are low gradient, channels in which significant morphologic adjustments occurs in response to increased sediment supply. Typically, these types of channels are the depositional reaches of stream networks. Sediment is collected and accumulated in these segments.

Plane Bed channels tend to have planar channel beds with occasional channel spanning rapids. They are distinguished from step-pool and pool-riffle channels in that they lack rhythmic bedforms. These channels may lack sufficient flow dynamics to cause pool development except where obstructions such as large wood debris create local pool or bar formation. These channels occur in confined and unconfined valleys and hence, have a variety of responses to changes in sediment and discharge. Potential responses include channel widening, incision, bed aggradation, and changes in size of streambed materials.

Pool-riffle channels have a sequence of bars, pools, and riffles and tend to have the widest variety of potential responses. These channels are generally unconfined, which allows widening in response to either increased discharge or sediment

supply. Increased discharge may also cause bank cutting and meander. Sediment deposition can occur with higher sediment loads or decreased discharge. High peak flows can potentially increase the depth of scour and decrease sediment storage. Less frequent high flows favor pool filling and increased sediment storage.

Regime channels are low gradient, sand-bedded channels exhibiting a succession of bedforms with increasing flow velocity. Some reaches in gravel and boulder bedded channels also exhibit regime channel characteristics. With increasing flow velocity bedforms are created in a sequential pattern of planar bed, ripples, sand waves, dunes, high-energy planar bed, and finally antidunes. In coarser stream beds, bedload migrates in sheets and bedforms are less distinguishable. Regime channels have the lowest relative transport capacities may widen in response to either increased discharge or sediment deposition. Increased discharge can also result in meandering or channel migration.

Braided channels have a condition of high sediment supply relative to transport capacity. A significant increase in discharge or decrease in sediment supply may result in conversion to a single thread channel. Conversely, an increase in sediment deposition may result in further widening of the active channel and development of multiple channels. Plane bed and regime channels may convert to braided channels with increases in sediment or decrease in discharge.

Table 9. Hydrologic Properties and Responses

LTA	Surface Runoff	Channel Density	Stream Flow Duration	Stream Flow Amount	Aquifer Recharge	Stream Types	Stream Reach Processes
114	Low	Low	Intermittent or Perennial	Low flow	Moderate	A, B	Source, Transport
115	Moderate	Moderate	Intermittent or Perennial	Low flow	Moderate to High	A, B	Source
116	Low	Low	Intermittent	Occasional storm flow	Low	Low gradient colluvial	Source
117	Moderate	Moderate	Intermittent or Perennial	Low flow	Low	A, B	Source, Transport
118	Moderate	Moderate- High	Intermittent	Low flow	Low	Aa, A, B	Source, Transport
124	Low	Low	Intermittent or Perennial	Low flow	Moderate	A, B	Source, Transport
125	Moderate	Moderate	Intermittent or Perennial	Low flow	Moderate	A, B	Source
126	Low	Low	Intermittent	Low flow	Low	Low gradient colluvial	Source
127	Moderate	Moderate	Intermittent or Perennial	Low flow	Low	A, B	Transport
131	Low	Moderate	Perennial	High flow	Moderate to High	B, C, D, E	Transport, Response
132	Flashy	High	Intermittent	Low flow	Low	Aa, A, B	Source, Transport
133	Low	Moderate	Perennial	High flow	Moderate to High	C, D, E	Response
135	Moderate	High	Perennial	Flow varies	High	B, C, E	Source, Transport, Response
144	Low	Low	Intermittent or Perennial	Low flow	Moderate	A, B	Source, Transport
146	Low	Low	Intermittent	Occasional storm flow	Low	A, B	Source
155	Moderate	Moderate	Intermittent	Low flow	Moderate	A, B	Source
156	Low	Low	Intermittent	Occasional storm flow	Low	Low gradient colluvial	Source
157	Moderate	Low	Intermittent or Perennial	Low flow	Low	A, B	Source, Transport

Table 9. Hydrologic Properties and Responses

LTA	Surface Runoff	Channel Density	Stream Flow Duration	Stream Flow Amount	Aquifer Recharge	Stream Types	Stream Reach Processes
158	Flashy	High	Intermittent	Low flow	Low	Aa, A, B	Source, Transport
165	Moderate	Moderate	Intermittent	Low flow	Moderate	A, B	Source
166	Low	Moderate	Intermittent	Occasional storm flow	Low	Low gradient colluvial	Source
167	Moderate	Moderate-High	Intermittent or Perennial	Low flow	Low	A, B	Source, Transport
168	Moderate	High	Intermittent	Low flow	Low	Aa, A, B	Source, Transport
176	Low	Low	Intermittent	Occasional storm flow	Low	Low gradient colluvial	Source
177	Moderate	Low-Moderate	Intermittent or Perennial	Low flow	Low	A, B	Source, Transport
214	Low	Low	Intermittent or Perennial	Low flow	Moderate	A, B	Source, Transport
215	Moderate	Moderate	Intermittent	Low flow	Moderate to High	Low gradient colluvial, A, B	Source, Transport
216	Low	Low	Intermittent	Occasional storm flow	Low	Low gradient colluvial	Source
217	Moderate	Low-Moderate	Intermittent or Perennial	Low flow	Low	A, B	Source, Transport
218	Flashy	Moderate-High	Intermittent	Low flow	Low	Aa, A, B	Source, Transport
224	Moderate	Low	Intermittent or Perennial	Low flow	Moderate	A, B	Source, Transport
226	Low	Low	Intermittent	Occasional storm flow	Low	Low gradient colluvial	Source
227	Moderate	Moderate	Intermittent or Perennial	Low flow	Low	A, B	Source, Transport
231	Low	Moderate	Perennial	High flow	High	B, C, D, E	Transport, Response
232	Flashy	High	Intermittent	Low flow	Low	Aa, A, B	Source, Transport
233	Low	Moderate	Perennial	Flow varies	Moderate to High	C, D, E	Response

Table 9. Hydrologic Properties and Responses (cont)

LTA	Surface Runoff	Channel Density	Stream Flow Duration	Stream Flow Amount	Aquifer Recharge	Stream Types	Stream Reach Processes
236	Low	Moderate-High	Intermittent or Perennial	Low flow	Moderate to High	C, E (low gradient colluvial)	Source, Response
244	Moderate	Low	Intermittent or Perennial	Low flow	Moderate	A, B	Source, Transport
246	Moderate	Low	Intermittent	Occasional storm flow	Low	Low gradient colluvial	Source
256	Low	Low	Intermittent	Occasional storm flow	Low	Low gradient colluvial	Source
257	Moderate	Low	Intermittent or Perennial	Low flow	Low	A, B	Source, Transport
258	Flashy	Moderate-High	Intermittent	Occasional storm flow	Low	Aa, A, B	Source, Transport
265	Low	Moderate	Intermittent	Low flow	Moderate	A, B	Source
266	Low	Moderate	Intermittent	Occasional storm flow	Low	Low gradient colluvial	Source
267	Moderate	Moderate-High	Intermittent or Perennial	Low flow	Low	A, B	Source, Transport
268	Flashy	High	Intermittent	Low flow	Low	Aa, A, B	Source, Transport
273	Low	Low	Intermittent or Perennial	Flow varies	Moderate to High	B, C, D	Transport, Response
275	Low	Moderate	Intermittent or Perennial	Low flow	Moderate to High	B, C	Transport, Response
276	Low	Low	Intermittent	Occasional storm flow	Low	Low gradient colluvial	Source
277	Moderate	Low-Moderate	Intermittent or Perennial	Low flow	Low	A, B	Source, Transport
315	Moderate	Moderate	Intermittent	Low flow	Moderate	Low gradient colluvial, A, B	Source, Transport
316	Low	Low	Intermittent	Occasional storm flow	Low	Low gradient colluvial	Source, Response
317	Moderate	Low-Moderate	Intermittent	Low flow	Low	A, B	Source, Transport
318	Flashy	Moderate-High	Intermittent	Occasional storm flow	Low	Aa, A	Source, Transport
326	Low-Moderate	Low-Moderate	Intermittent	Occasional storm flow	Low	Aa, A	Source, Transport

Table 9. Hydrologic Properties and Responses

LTA	Surface Runoff	Channel Density	Stream Flow Duration	Stream Flow Amount	Aquifer Recharge	Stream Types	Stream Reach Processes
327	Flashy	Low-Moderate	Intermittent	Occasional storm flow	Low	Aa, A	Source, Transport
332	Flashy	High	Intermittent	Low flow	Low	Aa, A, B	Source, Transport
333	Low	Moderate	Intermittent or Perennial	Flow varies	Moderate to High	C, D	Transport, Response
356	Low	Low	Intermittent	Occasional storm flow	Low	Low gradient colluvial, A, B	Source, Transport
357	Moderate	Low	Intermittent	Occasional storm flow	Low	A, B	Source, Transport
358	Flashy	Moderate-High	Intermittent	Occasional storm flow	Low	Aa, A	Source, Transport
365	Moderate	Low-Moderate	Intermittent	Low flow	Moderate	A, B	Source, Transport
366	Low	Low-Moderate	Intermittent	Occasional storm flow	Low	Low gradient colluvial, A, B	Source, Transport
367	Moderate	Moderate-High	Intermittent	Low flow	Low	A, B	Source, Transport
368	Flashy	High	Intermittent	Occasional storm flow	Low	A, B	Source, Transport
376	Low	Low	Intermittent	Occasional storm flow	Low	Low gradient colluvial, A, B	Source, Transport
377	Moderate	Low	Intermittent	Low flow	Low	A, B	Source Transport
416	Low	Low	Intermittent	Occasional storm flow	Low	Unknown	Source, Transport
418	Flashy	Low-Moderate	Intermittent	Unknown	Low	A	Source
432	Flashy	High	Intermittent	Unknown	Low	Aa, A	Source
433	Low	Moderate	Perennial	High flow	High	C, D, E	Response
468	Flashy	High	Intermittent	Unknown	Low	Aa, A	Source
518	Flashy	Moderate	Intermittent	Occasional storm flow	Low	Aa	Source

Table 9. Hydrologic Properties and Responses (cont)

LTA	Surface Runoff	Channel Density	Stream Flow Duration	Stream Flow Amount	Aquifer Recharge	Stream Types	Stream Reach Processes
532	Flashy	High	Intermittent	Occasional storm flow	Low	Aa	Source
558	Flashy	Moderate-High	Intermittent	Occasional storm flow	Low	Aa	Source
567	Flashy	High	Intermittent	Occasional storm flow	Low	Aa	Source
568	Flashy	High	Intermittent	Occasional storm flow	Low	Aa	Source
600	n/a	n/a	n/a	n/a	High	n/a	n/a
736	Moderate	High	Intermittent or Perennial	Low flow	Moderate to High	C, D, F, E	Response
832	Flashy	Moderate	Intermittent	Occasional storm flow	Low	Aa	Source

Sedimentation Processes and Responses

Table 10 lists several geomorphic processes that influence sediment flow in a watershed. Below is a brief description of the information contained in each column of the table.

Soil Erosion (disturbed): This column contains the interpretation for the potential for surface erosion upon removal of all vegetation material including the forest floor layer. These conditions often exist after a severe fire that consumes 100% of the forest floor, on an unvegetated road cut/fill slope or on a skid trail. In these conditions, slope gradients over 15% are generally steep enough to cause serious rill erosion and/or dry ravel. Erosion ratings are heavily weighted by slope gradient with a slight modification for the resistance or lack of erosion resistance from different soil textures.

LOW (L) - Landtype Associations generally contain site features that limit the probability of sheet erosion. Generally the site conditions include sufficient rock fragments to armor surfaces, irregular and complex slope shapes with less than 20% gradients, cohesive soils with moderately fine and fine textures, rapid vegetation recovery, and/or surface water runoff is seldom concentrated.

MODERATE (M) - Landtype Associations generally contain site features that limit sheet erosion to rilling. Erosion control treatments and design is normally required on bare surfaces and is usually adequate in controlling surface erosion. Generally the site conditions include some rock fragments but insufficient to fully armor the surface, long straight slopes with 20-45% gradients, medium and moderately coarse textured soils, moderately rapid vegetation recovery (2-5 yrs), and/or some probability of concentrated surface runoff.

HIGH (H) - Landtype Associations generally contain site features that develop extensive rilling which can enlarge into gullies. Special erosion control treatments and design should be a standard practice and may not be totally successful. Generally the site conditions include long straight slopes with gradients exceeding 45%, coarse to moderately coarse textured soils, vegetation recovery is slow (greater than 5 years), and/or high probability of concentrated surface runoff.

Soil Erosion (undisturbed): This column contains the interpretation for the potential for surface erosion in a relatively natural setting or lightly disturbance. The factors used for erosion ratings are slope gradient, understory vegetation cover and type, and field observed duff layers.

LOW (L) - Landtype Associations generally contain site features that limit the probability of sheet erosion. Generally the site conditions include thick duff layers, dense understory vegetation cover with slope gradients less than 60%, and medium textured surface soil layers.

MODERATE (M) - Landtype Associations generally contain site features that limit sheet erosion to rilling. Generally the site conditions include the presence of duff layers and some understory vegetation cover with slope gradients ranging from 30- 90%, or coarse textured soils on slopes between 30-60% with intermittent duff layers and sparse understory vegetation cover; or grass meadows with slopes between 30-60% with surface

cover of greater than 70% and medium to moderately coarse soil textures.

HIGH (H) - Landtype Associations generally contain site features that have high natural rates of erosion. Site factors include slope gradients greater than 60% with moderately coarse or coarse textured soils with a lack of continuous duff layers or understory vegetation cover; areas with a high amount of exposed rock outcrop and low forest canopy cover; and grass meadows with less than 30% ground cover.

Landslide (deep seated): This column contains the interpretation for the potential for deep seated mass movement. These landslides have been included in the mapping differentia for LTAs and are the Landform Group – Landslides. Earth movement is either large masses of slow-moving earth that move along a shear plane deep in the regolith or bedrock or moderate size masses that move along a moderately deep shear plane relatively rapidly but only sporadically. The relative potential of movement and location varies depending on whether the landslides are ancient features with only unstable margins along active stream courses, dormant features having a higher likelihood of movement when in contact with water tables; and actively moving features. The hazard rating is constructed to interpret the potential for movement in the worst case situation and at the most unstable location.

A number of complex factors influence *deep-seated landslides* (Dragovich and Brunengo 1995, Swanson and Swanston 1977, and Sidle 1985). Many of these site factors were used for developing deep seated landslide hazards. They are:

1. easily weathered bedrock high in minerals weathering to clay
2. geologic structural features such as folding, faulting, and/or interbedded strata
3. geomorphic shape features (escarpments and converging concave topography)
4. fine textured surficial deposits
5. slope gradients greater than 20 percent
6. indications of concentrated ground water
7. indications of surface and subsurface water

LOW (L) - Landtype Association has very few of the properties associated with landside probability. Little evidence of landslides has been observed. The degree of limitation is minor and can be overcome easily.

MODERATE (M) - Landtype Association has properties commonly associated with landslide probability. These properties occur over a small extent of the area. Evidence of landslides has been observed but is not common. The degree of limitation can usually be overcome by special planning, design, or maintenance.

HIGH (H) - Landtype Association has most of the properties associated with landslide probability. Evidence of landslides has been observed over most of the area. The degree of limitation generally requires major reclamation, special design, or intensive maintenance.

Landslide (shallow rapid): This column contains the interpretation for the potential for shallow rapid landslides. These landslides tend to originate on very steep landforms where a complex of pockets of deep soils usually in colluvial channels are in complex with shallow soils and bedrock. The landform, Canyons, is the most representative of this landform/soil condition. The frequency and rate of these landslides varies with climatic regimes. In the Blue Mountains, the natural frequency would be likely associated with storm events that exceed 100 year storm events. Roads and harvest have the potential to accelerate natural rates and frequency.

A number of complex factors influence *shallow-rapid landslides* (Dragovich and Brunengo 1995, Sidle 1985, Swanston 1970 and 1974, Wu & Swanston 1980). Many of these site factors were used for developing deep seated landslide hazards. They are:

1. slope gradients greater than 40%
2. convergent drainages and/or catchment basins
3. unconsolidated coarse textured soils
4. interface of materials with discontinuous hydrologic properties
5. sparse vegetation patterns
6. geomorphic features (debris chutes associated with debris cones or alluvial fans)
7. high low order drainage density especially with parallel patterns

LOW (L) - Landtype Association has very few of the properties associated with landside probability. Little evidence of landslides has been observed. The degree of limitation is minor and can be overcome easily.

MODERATE (M) - Landtype Association has properties commonly associated with landslide probability. These properties occur over a small extent of the area. Evidence of landslides has been observed but is not common. The degree of limitation can usually be overcome by special planning, design, or maintenance.

HIGH (H) - Landtype Association has most of the properties associated with landslide probability. Evidence of landslides has been observed over most of the area. The degree of limitation generally requires major reclamation, special design, or intensive maintenance. Accelerated sedimentation is likely to occur even with special management practices.

Sediment Delivery Efficiency: This column contains the interpretation of the relative efficiency of landforms to route eroded debris into first order stream channels and deliver sediment into mainstem streams. The factors used to rate Landtype Associations are: surface runoff response, slope gradient and shape, low order stream density, stream channel geomorphic type; position in the watershed in terms of distance to a mainstem perennial channel; and potential for shallow rapid landslides. This interpretation excludes the sediment delivery processes associated with streambanks and toeslopes along mainstems as it is a site-scale interpretation not landscape level interpretation.

LOW (L) - Landscapes can absorb a great deal of surface water before individual soil particles are detached. Surface runoff normally is well dispersed and does not become concentrated in first order streams. Landtype Association features limit surface water

and sediment from being routed quickly to first order stream systems. First order stream catchment basins do not have evidence of rilling and channels do not have a history of scour or non-vegetated deposition. Normally these Landtype Associations have not had a history of shallow rapid landslides being delivered into mainstem streams. Usually Landtype Associations have a set of the following site features: low slope gradients <25%, more than 80 percent vegetation cover; deep, moderately coarse textured regoliths; very little exposed bedrock; low drainage density first order streams; area not normally exposed to rain-on-snow events or high intensity rainstorms.

MODERATE (M) - Landscapes absorb some surface water before individual soil particles are detached. Surface runoff is somewhat well dispersed but some concentrated flows are routed into first order drainages. Landtype Association features are somewhat efficient in routing surface water and sediment into first order stream systems. First order stream catchment basins have some evidence of past rilling and stream channels have some evidence of scour. Slope shapes are complex with breaks in slope gradient that offer slope storage of eroding debris prior to reaching stream channels. Usually Landtype Associations have a set of the following site features: slope gradients between 25 and 45 percent; vegetation cover is 30 to 80 percent; regolith depths that vary from shallow to moderately deep; exposed bedrock is less than 25 percent of the area; moderate drainage density of confined or entrenched first order stream systems with both source and transport stream types; area exposed to infrequent rain-on-snow events or high intensity rainstorms.

HIGH (H) - Landscapes do not absorb a great deal of surface water before individual soil particles detach. Surface runoff is poorly regulated and concentrated flows are routed rapidly into first order drainages. Landtype Association features are extremely efficient in routing surface water and sediment into first order stream systems. Slope shapes are less complex with few breaks in grade to offer slope storage of eroding debris. First order catchment basins have evidence of past rilling and stream channels have evidence of scour or non-vegetated deposition. Normally these Landtype Associations have had a relatively frequent history of shallow rapid landslides or high incidence of source type, colluvial channels deliver directly into mainstem streams. Usually Landtype Associations have a set of the following site features: steep slope gradients (45%+); less than 30 percent vegetation cover; shallow regoliths; exposed bedrock exceeds 25 percent of the area; high drainage density of confined or entrenched first order streams; area is exposed to frequent rain-on-snow events or high intensity rainstorms.

Table 10: Sedimentation Properties and Responses

LTA	Sediment Delivery Efficiency	Soil Erosion (Disturbed)	Soil Erosion (Undisturbed)	Landslides Deep-Seated	Landslides Shallow-Rapid
114	L-H	H	L	M	M
115	L-M	M-H	L	L-M	L
116	L	L-M	L	L	L
117	M	H	L	L-M	M
118	H	H	M	L-M	H
124	L-H	L-H	L	H	L
125	L-M	L-M	L	H	L
126	L	L	L	M	L
127	M	M-H	L	M-H	L
131	L	L-M	L	L-M	L
132	H	M-H	L-H	L-M	M-H
133	L-H	L	L	L	L
135	L-M	M-H	L	L-M	L
144	L	M	L	H	L
146	L	L	L	M	L
155	L-M	H	M	M-H	L
156	L	M-H	L	L	L
157	M	H	M	M	L
158	H	H	H	M	H
165	L-M	M-H	L	M	L
166	L	L-M	L	L	L
167	M	H	L	L-M	M
168	H	H	M	M-H	H
176	L		L	L-M	L
177	M	H	L	M-H	L
214	L-H	L-H	L-M	M-H	L
215	L-M	M-H	M	L-M	L
216	L	L-M	L	L	L
217	M	H	L-M	L	L
218	H	H	M	L	H
224	L-M	L-H	L	H	L
226	L	L-M	L	L-M	L
227	M	M-H	L	M-H	M

Table 10: Sedimentation Properties and Responses

LTA	Sediment Delivery Efficiency	Soil Erosion (Disturbed)	Soil Erosion (Undisturbed)	Landslides Deep-Seated	Landslides Shallow-Rapid
231	L	M-H	L	L	L
232	H	M-H	L-H	L-M	M-H
233	L-H	L	L	L	L
236	L	L-M	L	L	L
244	L-H	L-H	L	H	L
246	L	L-M	L	M	L
256	L	L-M	L	L	L/L
257	M	H	M-H	M	M-H
258	H	H	M	M	H
265	L	H	L	L-M	L
266	L-M	M	L-M	L	L
267	M	H	M	L-M	M
268	H	H	M-H	M	H
273	L-H	L	L	L	L
275	L-M	L	L	L	L
276	L	M	L	M	L
277	M	H	L	M-H	L
315	L-M	M-H	L-M	L	L
316	L	L-M	L-M	L	L
317	M	M-H	M	L	L
318	H	H	H	M	H
326	L	M	L-M	L	
327	M	H	M	M	L
332	H	M-H	L-H	M	H
333	L-M	L	L	L	L
356	L	M	L-M	L-M	L
357	M	H	M-H	L-M	M
358	H	H	H	L-M	H
365	L	M-H	L-M	L-M	L
366	L	L-M	L-M	L	L
367	M	H	L	L-H	L-M
368	H	H	H	M-H	H
376	L	L-M	L-M	L	L
377	M	H	M	M	L

Table 10: Sedimentation Properties and Responses

LTA	Sediment Delivery Efficiency	Soil Erosion (Disturbed)	Soil Erosion (Undisturbed)	Landslides Deep-Seated	Landslides Shallow-Rapid
416	L	M	L-M	L	L
418	H	H	M	M	H
432	H	M-H	L-H	L	M-H
433	L-H	L	L	L	L
468	H	H	M	M-H	H
518	H	H	H	M	H
532	L-H	M-H	L-H	M	H
558	H	H	H	M	H
567	H	H	L	L	
568	H	H	H	L	H/H
736	L-H	L-M	M	L	M
832	M-H	H	H	L	M

Fish and Wildlife Habitat

Table 11 contains the Wildlife and Fish Potential Habitat and Responses for each Landtype Association. Listed below is a brief description of the information contained in each column of the table.

Unique Habitat Features: This column contains some of the site properties that provide important habitat components for some wildlife species. The presence or absence of these properties is normally linked to geomorphic expression. They were identified on aerial photographs at 1 inch equals one mile scale (1:63,360) and observations were supported by field experience of the mapping team. In some cases, site features, not easily seen on aerial photographs were inferred through processes or site-scale landforms that are associated with geomorphic expression. For example, larger seeps are identifiable by vegetation type and pattern. Exact locations of smaller seeps may not be seen on aerial photography but can be inferred through extrapolation of known slope configuration and groundwater movement controlled by a landform, its typical position and geomorphic history in a watershed, and/or geology group. Some glacial landforms are highly predictable in this regard, in that, glacial deposits often occur along or at the toe of steep sideslopes where groundwater is intercepted.

Potential Lynx Habitat: This column contains an interpretation of the quality of habitat for potential Lynx habitat in each Landtype Association. The interpretation is for potential and not existing habitat quality. Potential habitat is important because the natural role of fire disturbance will likely alter present and future habitat quality. The highest quality habitat is associated with forests with a structure that includes branches low to the ground; has persistent winter snow with depths exceeding 2 feet; and slope gradients less than about 30 percent. Lodgepole pine seral forests within the subalpine fir series offer the greatest potential for the largest contiguous area having the first two listed habitat features. Although, other series have lodgepole pine seral forests and other associated factors such as snow depth and forest structure, they usually lack consistent presence over large land area and hence, have less potential to provide contiguous quality habitat. Potential Natural Vegetation (PNV) was used to predict potential for forest type and structure components and geomorphic expression or landform was used to interpret slope gradient.

Travel corridors are an important component of Lynx habitat. Again, interpretation ratings are in terms of potential not existing. The criteria used in this interpretation are: continuous slope gradients less than 30 percent on landforms with persistent winter snow.

VERY HIGH (VH) - Landtype Associations contain a preponderance of subalpine fir series and landforms with slope gradients less than 30 percent.

VERY HIGH (VHT) - Landtype Associations contain very high quality habitat as well as possible major travel corridors. Units contain a preponderance of subalpine fir series and consist of broad gently rolling ridge tops with slopes generally less than 30 percent.

HIGH (H) - Landtype Associations contain subalpine fir series and landforms with slope gradients generally less than 30 percent; however some slopes exceed 30 percent.

MODERATE (M) - Landtype Associations contain subalpine fir series and landforms with slope gradients that generally exceed 30 percent; however inclusions of slope gradients less than 30% may occur.

LOW (L) - Landtype Associations contain moist Douglas-fir, grand fir, and western redcedar/hemlock series and have landforms with slope gradients generally less than 30 percent; however, some slopes exceed 30 percent.

VERY LOW (VL) - Landtype Associations contain moist Douglas-fir, grand fir, and western redcedar/hemlock series and have landforms with slope gradients that generally exceeding 30 percent; however, some slopes are less than 30 percent.

Potential Wolverine Denning Habitat: This column contains an interpretation of the quality for wolverine denning habitat in each Landtype Association. The criteria or factors used to help develop denning habitat are as follows: aspect; relief; elevation, presence of boulder talus, and snow depth and persistence during denning season (Copeland 1996). Only HIGH and MODERATE quality ratings are displayed. Those Landtype Associations without a rating should be considered to have low quality denning habitat.

HIGH (H) - All site features for high quality denning habitat exist in the Landtype Association. Landtype Associations are on north or northeast aspects; have boulder talus slopes; are above 5500 feet elevation and have at least moderate depths of winter snow; and have concave to flat slope configuration. Cirque basins contain all of these site features.

MODERATE (M) – Some but not all of the site qualities associated with denning habitat is present in the Landtype Association. Typically, these LTAs include some boulder talus but may not include all of the other important site properties such as aspect, relief, and elevation features.

Mule Deer Winter Range: This column contains the relative interpretation of the quality for mule deer winter range in each Landtype Association. The criteria or factors used to help identify mule deer winter range habitat are as follows: southern exposures; slope; elevation zone linked to low snow-fall areas, vegetation zones, and adjoining security areas. Only HIGH and MODERATE ratings are displayed. All other Landtype Associations would be considered to have low quality Mule Deer Winter Range.

HIGH (H) – Landtype Associations consist of the following: south-facing aspects with ponderosa pine and shrub-steppe potential natural vegetation; slopes are generally below 3500 feet in elevation; and slope gradients are greater than 30 percent. These south facing slopes are adjacent to north-facing slopes that support dense canopied forests within the Douglas-fir series that provide thermal cover.

MODERATE (M) - Landtype Associations that generally lack the ponderosa pine vegetation zone component but include all the other winter range factors or criteria.

Security Cover (S) – Landtype Associations have a high potential to provide security cover in close association with mule deer winter range. Landtype Association features used to indicate potential security cover are: potential natural vegetation series which support multi-layered dense forests that provide vegetative screening; and landforms

associated with narrow canyons or with a high complexity of dissection or change in slope shape that reduces distance of line of sight.

Mountain Goat Habitat: This column contains the relative interpretation of the quality for Mountain Goat Habitat in each Landtype Association. The criteria or factors used to help identify mountain goat habitat are as follows: avalanche chutes; scree or talus slopes, slope gradients exceeding 75 percent; abundant bedrock exposures; alpine meadows, and timber-line vegetation zones. Only HIGH and MODERATE quality ratings are displayed. All the other Landtype Associations would be considered to have low quality mountain goat habitat.

HIGH (H) - Landtype Associations that contain all of the habitat features associated with high quality habitat such as; avalanche chutes, scree and talus slopes, slopes greater than 75 percent, abundant bedrock exposures, alpine meadows, and timber line forest zones (subalpine and mountain hemlock vegetation zones).

MODERATE (M) - Landtype Associations that contain many but not all of the habitat features associated with high quality habitat. The missing features significantly reduce the quality of habitat.

WINTER RANGE (W) - Landtype Associations that contain all of the habitat features association with high quality winter range, such as; slopes greater than 75 percent, abundant bedrock exposures, winter snow depths less than two feet, security cover vegetation; southern exposures or vegetation zones that represent warm dry conditions; and foraging habitat associated with Douglas-fir/ponderosa pine potential natural vegetation zones.

Bull Trout Spawning/Rearing: This column contains the relative interpretation of potential spring upwelling areas along stream channels within each Landtype Association. Spring upwelling tends to help maintain adequate stream flow and moderates water temperatures (Baxer and Hauer 2000). Site factors used to identify potential upwelling areas include: thick, unconsolidated glacial drift deposits occurring below prominent "rocky" ridges; concave slope relief normally characteristic of U-shaped glacial valleys; stream segments bounded by alluvial fans in valley bottom positions; mainstem channel morphology interrupted by bedrock nick-points; and known spring upwelling areas identified by field observations. Only HIGH and MODERATE ratings are displayed. All the other Landtype Associations would be considered to have low probability for spring upwelling.

HIGH (H) - Landtype Associations contain all features associated with spring upwelling that may produce high quality bull trout spawning/rearing habitat. The site features include: thick, unconsolidated glacial drift deposits; glacial drift deposits occur below prominent "rocky" ridges; concave slope relief characteristic of U-shaped glacial valleys; stream segments that are bounded by coalescing alluvial fans; and occasional bedrock nick-points in the valley floor.

MODERATE (M) - Landtype Associations that contain many but not all of the features associated with spring upwelling that may produce quality of bull trout spawning/rearing. Site features include: glacial drift deposits but are not found in glacial U shape valleys and are not associated with upper "rocky" ridges.

Table 11. Fish and Wildlife Habitat

LTA	Seeps	Ponds	Streams	Cliffs	Talus	Avalanche chutes	Wet Meadow	Grassland	Lynx Habitat	Wolverine Denning	MuleDeer Winter Habitat	Mountain Goat	Moose	Trout Spawn Rearing
114	High						Moderate							
115	Low						High		High Travel					
116									High Travel					
117	Low			Moderate					Moderate		Moderate Security			
118				High	Moderate				Moderate		Moderate Security			Moderate
124	High						Moderate		High					
125	Low						Moderate		High					
126									High Travel					
127	Moderate			Moderate					Moderate					
131	Moderate	High					High		Very High	High			High	High
132				High	High	High			Very High	High		Moderate		
133			High				High		High				Moderate	High
135			High				Moderate		Moderate	High				Moderate
144	High								Moderate					
146	Low								Moderate					
155									Moderate					
156									High Travel					
157									High					
158				Moderate	High									
165														
166									Moderate Travel					
167									Moderate		Moderate Security			

Table 11. Fish and Wildlife Habitat (cont)

LTA	Seeps	Ponds	Streams	Cliffs	Talus	Avalanche chutes	Wet Meadow	Grassland	Lynx Habitat	Wolverine Denning	MuleDeer Winter Habitat	Mountain Goat	Moose	Trout Spawn Rearing
168											Moderate Security			
176														
177														
214	High						Moderate		Low					
215	Low						Moderate	Moderate	Low					
216									Low					
217				Moderate				Moderate			High Security			
218				High	High			Moderate			High Security			Moderate
224	High						Moderate							
226								Moderate						
227	Moderate							Moderate			High Security			
231	Moderate		High				High		Moderate	High			High	High
232				High	High	High				High		Moderate		
233			High						Moderate					High
236									Moderate					
244	High						Moderate							
246								Moderate						
256									Low					
257									Low					
258				High	High									
265														
266									Low					
267									Low		High Security			

Table 11. Fish and Wildlife Habitat (cont)

LTA	Seeps	Ponds	Streams	Cliffs	Talus	Avalanche chutes	Wet Meadow	Grassland	Lynx Habitat	Wolverine Denning	MuleDeer Winter Habitat	Mountain Goat	Moose	Trout Spawn Rearing
268				Moderate	Moderate						High Security			
273			High				Moderate	Moderate						
275														
276														
277											High Security			
315							Moderate	High						
316								High						
317				Moderate				High			High			
318				High	High			High			High			
326								High						
327								High			High			
332			High			High	High	High				Moderate		
333			High				Moderate	High						Moderate
356								High						
357								High			High			
358				High	High			High			High			
365								High						
366								High						
367								High			High			
368				Moderate	High			High			High			
376								High						
377								High			High			
416							Moderate							

Table 11. Fish and Wildlife Habitat (cont)

LTA	Seeps	Ponds	Streams	Cliffs	Talus	Avalanche chutes	Wet Meadow	Grassland	Lynx Habitat	Wolverine Denning	MuleDeer Winter Habitat	Mountain Goat	Moose	Trout Spawn Rearing
418				High	High						Moderate			
432		Moderate												
433			High				High						Moderate	High
468				Moderate	High									
518											High			
532				High	High	High	High			Moderate		High		
558					High						High			
567					Moderate						High			
568				High	High						High			
736			Moderate				High	High					Moderate	Moderate
832				High	Moderate	Moderate		High	Moderate	Moderate		High		

Vegetation Properties and Response

Table 12 contains the vegetation properties and responses for each Landtype Association. Listed below is a brief description of the information contained in each column.

Vegetation Zone: This column contains the potential natural vegetation group which is an aggregation of Plant Association Groups (PAG). Each zone represents a unique and contrasting ecological processes that influence productivity, understory and overstory density, and recovering from disturbance. For further explanation on composition and how these categories were constructed consult Parts I and II of this report.

Non-Forest Area (%): This column lists the estimated average area with non-forest. Non-forest represented is comprised of grass, shrub or rock. Non-forest area was estimated using the initial vegetation layer, Landtype Phase which mapped complexes and individual map units of non-forest areas. The Landtype Phase map was created from various sources of existing vegetation mapping and plant association classifications from stand exam data.

Vegetation Zone (Wood Fiber) Productivity: This column lists ratings for vegetation zones using Forest Productivity Classes as listed in Appendix E, "Plant Associations of the Blue and Ochoco Mountains" by Charles Grier Johnson, Jr. and Rodrick R. Clausnitzer (Johnson and Clausnitzer 1992). The most common plant associations observed to occur in each Vegetation Zone was used to apply productivity classes. Ranges of productivity are given when the Vegetation Zone encompasses a large range of different plant associations and corresponding productivity. Ratings relate to the measure for average annual basal area growth and are as follows:

VL: Very Low - <20 cubic feet/acre/year
L: Low - 20-30 cubic feet/acre/year
M Moderate - 40-50 cubic feet/acre/year
H: High - 86-120 cubic feet/acre/year
VH: Very High - >121 cubic feet/acre/year

Inherent Soil Productivity: This column contains an interpretation of soil productivity as it influences overall forest productivity. The purpose of this interpretation is to provide a rating that can be used in association with Forest Productivity Classes to reflect an overall concept of productivity for each Landtype Association. This rating is provided in absence of actual site productivity data associated directly to each Landtype Association.

The principal soil properties used in this rating are soil depth, soil texture as it relates to water holding capacity, clay percent as it relates to cation exchange capacity, and general soil climate.

The ratings suggest whether the particular LTA is on the "low, mid, or high end" of the range given for a Forest Productivity Class as referenced in the prior rating column. More

than one rating reflects a complex of soils with distinctly different soil properties. Ratings are explained below:

VERY LOW (VL) – Site productivity is likely at the lowest end of the range of potential productivity for a given plant association group. The soil regolith has a relatively very low water holding capacity and nutrient availability due to coarse to moderately coarse textures with a high amount of coarse sands in the soil matrix, and/or severe moisture stress or cold temperatures limiting biological processes; and/or shallow soil depth and a high amount of bedrock exposure severely influences water or nutrient capacity.

LOW (L) - Site productivity is likely at the low end of the range of potential productivity for a given plant association group. The soil regolith has a relatively low water holding capacity and nutrient availability due to moderately coarse textures or somewhat finer textures that have limited biological processes due to cold temperatures or moisture stress or limited capacity due to shallow soil depths and a high amount of bedrock exposure.

MODERATE (M) - Site productivity is likely in the middle of the range of potential productivity for a given plant association group. The soil regolith has relatively moderate water holding capacity and nutrient availability due to moderately coarse to medium textures from geology parent materials that produce fine sands and silts in the matrix. Coarser, sandier soil textures are included when soils have a volcanic ash mantle or loess surface layer which substantially enhances productivity. Somewhat finer textures are included when it is expected that biological processes are limited due to cold temperatures or capacity is limited due to shallow soil depths and a high amount of bedrock exposure.

HIGH (H) - Site productivity is likely at the high or very high end of the range of potential productivity for a given plant association group. The soil regolith has a relatively high water holding capacity and nutrient availability due to moderately fine to fine textures. Most soils have a volcanic ash mantle that enhances productivity. Biological processes are not typically limited by cold temperatures.

<u>LTA Forest (Wood Fiber) Productivity:</u> This column contains the synthesis of the two columns, Vegetation Zone Productivity and Inherent Soil Productivity. The ratings listed estimate the potential productivity for the Landtype Association. Considered in the rating are the following: 1) plant associations are integrators of site factors that influence vegetation composition and diversity and relative productivity; and 2) specific soil properties have a direct influence on site productivity and a direct relationship to a given area's productivity. Ratings are defined as follows:

VL: Very Low - <20 cubic feet/acre/year
L: Low - 20-30 cubic feet/acre/year
M Moderate - 40-50 cubic feet/acre/year
H: High - 86-120 cubic feet/acre/year
VH: Very High - >121 cubicfeet/acre/year

<u>Herbage Production (air-dry/acre/yr):</u> This column contains an estimate of forage production in the forest understory and on grasslands. Forage as defined for this rating

includes forbs, grasses, and sedges. The ratings reflect an average range of production as extrapolated from clipping data (air-dry/acre/yr) for soil series and plant associations, respectively, from Umatilla County Soil Survey (USDA NRCS 1988) and Plant Associations of the Blue and Ochoco Mountains (Johnson and Clausnitzer 1992). This interpretation should be used to help compare herbage production between Landtype Associations and not as an absolute level of production. Annual production can vary greatly from year to year as precipitation amount and distribution varies. The production figures cited below are for an average to above average precipitation year.

VERY LOW (L) - Herbage production is less than 300 pounds of air dry weight per year. Landtype associations generally contain site features that infer very low productive conditions for herbage. Generally the area contains one or more of the following conditions: dense multi structured forest canopies; very shallow, rocky soils, soils easily eroded; and forest understories dominated by low and mid-level woody shrubs. Normally natural openings are a result of disturbance and are often dominated by mid to tall woody shrubs.

LOW (L) - Herbage production ranges from 300 to 500 pounds of air dry weight per year. Landtype associations generally contain site features that infer low productive conditions for herbage. Generally the area contains one or more of the following conditions: upper elevation alpine conditions; shallow grassland soils; relatively dense forest canopies; and forest understories dominated by low growing woody shrubs with some grasses.

MODERATE (M) - Herbage production ranges from 500 to 1000 pounds of air dry weight per year. Landtype associations generally contain site features that infer moderate or intermediate productive conditions for herbage. Generally the area contains one or more of the following conditions: open to partially closed, single-storied forest canopies; moderately deep grassland soils; and forest understories dominated by a mixture of grasses, forbs, and low growing woody shrubs.

HIGH (H) - Herbage production normally exceeds 1000 pounds of air dry weight per year. Landtype Associations generally contain site features that infer highly productive conditions for herbage. Generally the area contains one or more of the following site conditions: open meadows with only scattered coniferous trees; ground cover is dominated by a mixture of grasses, forbs, and sedges and/or grasslands associated with warm low level shrubs (juniper, bitterbrush and sagebrush); medium to moderately fine textured; depth of bedrock is greater than two feet; intermediate or subirrigated areas creating wet meadows or moist grasslands.

<u>Understory and Overstory Vegetation Recovery:</u> This column contains the interpretation for vegetation to regenerate after disturbance to support ground cover or pre-disturbance forest densities. The most common disturbance interpreted for is wildfire. Disturbance conditions considered are those where the forest floor is removed and the surface soil layer is exposed in forests and in meadows, vegetation is consumed to root crowns.

Site factors used to develop this interpretation include: harsh climatic conditions; moisture stress; soil erosion hazard; and unique soil regoliths such as from serpentine geology. Harsh climatic conditions are associated with subalpine/alpine elevations and support subalpine fir or whitebark pine or the Parkland Vegetation Zone. These high

elevations have short growing seasons or are exposed to desiccation by winds that limit plant growth. Moisture stress conditions are generally associated with a set of the following conditions: shallow surface horizons over coarse textured, bouldery regoliths; southern exposures; and low elevations were moisture and heat stress can affect seedling establishment. Moisture stress can occur in upper elevations associated with wind desiccation. Geologic features such as serpentine soils may produce soil chemical and physical properties that that hinder regeneration (Walker 1954).

VERY LOW (VL) - Site features generally cause extreme limitations for herbaceous vegetation and shrubs to regenerate and occupy sites or for seeds to germinate. Very harsh climatic conditions or soil/site features create extreme moisture stress, chronic erosion, or geologic features inhibit regeneration and vegetation establishment. Vegetation establishment is very slow and conditions may not sustain several pre-disturbance species. These site features are predominant in the area.

LOW (L) - Landtype Association contain site features that generally create limitations for herbaceous vegetation and shrubs to regeneration or for seeds to germinate. Harsh climatic conditions or soil/site features that create moisture stress, erosion, or geologic features limit regeneration. Vegetation establishment is slow and species diversity is limited for tens of years. These site features predominate throughout the area.

MODERATE (M) - Landtype Association generally contains soil or site features that create some limitations for herbaceous vegetation and shrubs to regenerate or for seeds to germinate. Vegetation occupies the site but competition for moisture or light may inhibit species diversity. Forests may be slow to reach pre-disturbance density. These site features are common but do not occur throughout the area.

HIGH (H) - Landtype Association generally contain site and soil features that do not limit herbaceous vegetation and shrubs from regenerating or seeds from germinating. Vegetation readily re-occupies the site with many pre-disturbance species represented. Forests regenerate readily to often higher than pre-disturbance density.

Table 12. Vegetation Properties and Responses

LTA	Vegetation Zone	Nonforest Area (%)	Vegetation Zone Productivity	Inherent Soil Productivity	LTA Forest Productivity	Herbage Production	Understory Recovery	Overstory Recovery
114	Moist Forest	0-10	M-VH	H	H,VH	L	M-H	H
115	Moist Forest	0-10	M-VH	H	H,VH	L	M-H	H
116	Moist Forest	0-10	M-VH	H	VH,H,M	L	M-H	H
117	Moist Forest	0-10	M-VH	H	H,MH,VH	L	M-H	H
118	Moist Forest	10-20	MH-VH	H	MH,M	L	M	H
124	Moist Forest	0-10	MH-VH	H	VH,H	L	M-H	H
125	Moist Forest	0-10	MH-VH	H	VH,H	L	M-H	H
126	Moist Forest	0-10	MH-VH	H	VH,H	L	M-H	H
127	Moist Forest	0-10	MH-VH	H	H,VH	L	M-H	H
131	Moist Forest	0-10	M-VH	H	H,VH,M	L	M-H	L-H
132	Moist Forest	10-20	VL-H	L,M	M,VL	L	L-M	L-H
133	Moist Forest	0-10	M-VH	M	H,M,VH	L	M-H	H
135	Moist Forest	0-10	M-H	VL, H	H,M,VL	L	H	H
144	Moist Forest	0-10	MH-VH	H	VH	L	H	H
146	Moist Forest	0-10	MH-VH	H	VH	L	H	H
155	Moist Forest	0-10	M-VH	M	H	L	M	H
156	Moist Forest	0-10	M-VH	M	H,VH,M	L	L-M	H
157	Moist Forest	0-10	M-H	M	H,M,VH	L	L-M	H
158	Moist Forest	0-10	M-H	M	M	L	L-M	H
165	Moist Forest	0-10	M-H	M	H	L	M	H
166	Moist Forest	10-20	M-VH	M	M,VH	L	M	H
167	Moist Forest	10-20	MH-VH	M	VH,H	L	M	H

Table 12. Vegetation Properties and Responses (cont)

LTA	Vegetation Zone	Nonforest Area (%)	Vegetation Zone Productivity	Inherent Soil Productivity	LTA Forest Productivity	Herbage Production	Understory Recovery	Overstory Recovery
168	Moist Forest	10-20	MH-VH	M	H,VH	L	L-M	H
176	Moist Forest	0-10	M-VH	M	M	L	M	H
177	Moist Forest	0-10	MH-VH	M	M	L	M	H
214	Dry Forest	0-10	M-H	MH	M,H	H	M-H	M
215	Dry Forest	20-30	M	MH	ML,M	MH	M-H	M
216	Dry Forest	20-30	M-H	VL,M	VL, M	M-MH	M-H	M
217	Dry Forest	20-30	M-H	M	M,H	M-MH	M-H	L-M
218	Dry Forest	30-40	VL-M	VL,MH	L,M,VL	M	M	L-M
224	Dry Forest	10-20	M	H	M,H	MH-H	M-H	M
226	Dry Forest	10-20	M-MH	H	M,MH	MH-H	M-H	M
227	Dry Forest	20-30	M-H	H	H	MH-H	M-H	L-M
231	Dry Forest	20-30	M-VH	M	MH,VH	ML-M	H	L-M
232	Dry Forest	30-40	VL-VH	VL, H	VH,VL	L	L-M	L-H
233	Dry Forest	10-20	M	M	M	MH-H	H	H
236	Dry Forest	30-40	M	M	M	MH-H	H	M
244	Dry Forest	10-20	M	MH	M	MH-H	H	M
246	Dry Forest	10-20	M	MH	M	MH-H	M-H	M
256	Dry Forest	20-30	M-H	L	L, ML	M	L-M	M
257	Dry Forest	20-30	M-H	L	ML	M	L-M	L-M
258	Dry Forest	20-30	M-H	L	ML	ML-M	L	L-M
265	Dry Forest	10-20	M-H	M	M	M	L-M	M

Table 11. Vegetation Properties and Responses (cont)

LTA	Vegetation Zone	Nonforest Area (%)	Vegetation Zone Productivity	Inherent Soil Productivity	LTA Forest Productivity	Herbage Production	Understory Recovery	Overstory Recovery
266	Dry Forest	10-20	VL-M	L,M	VL-M	M	L-M	M
267	Dry Forest	20-30	M-MH	M	M	M	L-M	L-M
268	Dry Forest	30-50	M-H	L,M	M,VL,ML	M	L	L-M
273	Dry Forest	20-30	L-M	M	M	MH	H	M
275	Dry Forest	30-50	L-M	M	M	MH	M-H	M
276	Dry Forest	20-30	VL-M	M	M	MH	M-H	M
277	Dry Forest	20-30	M-MH	M	M	MH	M	M
315	Dry NonForest	>80	VL	H	VL	H	H	L
316	Dry NonForest	>80	VL	L	VL	MH-H	H	L
317	Dry NonForest	>80	VL	M	VL	H	M-H	L
318	Dry NonForest	>80	VL	M	VL	MH-H	M	L
326	Dry NonForest	>80	VL	M	VL	H	H	L
327	Dry NonForest	>80	VL	M	VL	H	M-H	L
332	Dry NonForest	>80	VL	M	VL,M	H	L	L
333	Dry NonForest	>80	VL	M	VL	H	H	L
356	Dry NonForest	>80	VL-L	L	VL	MH	M	L
357	Dry NonForest	>80	VL-L	L	VL	MH	M	L
358	Dry NonForest	>80	VL	L	VL	MH	L-M	L
365	Dry NonForest	>80	VL	M	VL,L	M-H	M-H	L
366	Dry NonForest	>80	VL-L	M	VL,L	L-H	M-H	L
367	Dry NonForest	>80	VL	M	VL,L	L-H	M	L
368	Dry NonForest	>80	VL	L	VL,L	L-H	L-M	L

Table 12. Vegetation Properties and Responses (cont)

LTA	Vegetation Zone	Nonforest Area (%)	Vegetation Zone Productivity	Inherent Soil Productivity	LTA Forest Productivity	Herbage Production	Understory Recovery	Overstory Recovery
376	Dry NonForest	>80	VL-L	M	VL,L	L-H	M-H	L
377	Dry NonForest	>80	VL-M	M	VL L	L-H	M-H	L
416	Moist NonForest	>50	VL	M	VL	M-H	H	L
418	Moist NonForest	>50	VL	M	VL	M-H	M-H	L
432	Moist NonForest	>50	VL	M	VL	MH	M-H	L
433	Moist NonForest	>50	VL	M	VL	H	H	L
468	Moist NonForest	>50	VL	M	VL,L	H	M-H	L
518	Rock/Non-Veg	>50	VL	VL	VL	H	L	L
532	Rock/Non-Veg	>50	VL	VL	VL	L	L	L
558	Rock/Non-Veg	>50	VL	VL	VL	L	L	L
567	Rock/Non-Veg	>50	VL	VL	VL	L	L	L
568	Rock/Non-Veg	>50	VL	VL	VL	L	L	L
736	Non/Dry Forest/Riparian	>80	VL	M	VL	H	H	L
832	Very Cold Forest/NonForest	>60	VL	L	VL	ML-M	L	L

Management Considerations (Suitability and Limitations)

Table 13 lists the general suitability for and limitations to general forest management practices for each Landtype Association.

Road Construction: This column rates the suitability for the landscape to support road construction.

SUITABLE (S) - Limitations to road construction are rare or can be mitigated with common construction practices or more expensive construction practices commensurate with the value being accessed by the road.

UNSUITABLE (U) - Limitation to road construction present severe economic constraints and/or severe hazard to ecological processes. Road construction causing slope instability and/or chronic slope erosion degrading surface water quality and/or reducing site productivity are examples.

Limitation to Road Construction: Major limitations to road construction are listed. Similar limitations are listed for both suitable and unsuitable ratings. When accompanied with a suitable rating, the limitation can be mitigated either by special design, avoidance of feature by alignment, or the limitation by degree is less of a hazard to water quality or site productivity.

Slope stability - High hazard for chronic slope erosion, deep seated landslide, or shallow rapid landslides.

Drainage interception – High amount of seasonal groundwater or high density of channels require special design to manage water intercepted by road.

Sediment delivery – Road likely to deliver road produced sediment directly to a perennial stream or road is likely to be on slopes with high sediment delivery efficiency to a perennial stream.

Clay soil – Regolith has low bearing capacity or ruts easily when wet.

Rock – A high amount of resistant bedrock, talus, and/or boulder fields.

Stream channel – Difficult to avoid road alignment within a channel migration zone.

Cutslope erosion – Regolith erode easily ravelling into road ditches causing high maintenance costs and road drainage failure.

Wetland – Abundant persistently wet areas.

Riparian: This column identifies which Landtype Associations have a potential for a sizable riparian zone or wetlands within them. A (Y) in the column denotes "yes". An (*) indicates that the riparian zone may occur along the boundary of the map unit.

Limitation to Harvest Operability: This column lists the degree of limitation to operating ground-base harvest equipment. The ratings refer to the degree in which landscape features may constrain operability.

LOW (L) – Limitation can be easily mitigated or avoided. Often the mitigation is restriction of operating season.

MODERATE (M) – Limitations may constrain access to some areas within the LTA or limitations may not be easily mitigated. Common examples include slope steepness in some areas of the map unit exceed accepted gradient for use of ground-base equipment without impacts to site productivity or fine textured soils remain wet well into the operating season greatly condensing operating season to avoid rutting impacts to site productivity.

HIGH (H) – Limitations are severe and use of ground-base equipment have a high potential for degrading site productivity or pose safety risk to the operator. Commonly these areas have slope gradients that exceed 60% and/or rock outcrop in most of the map unit.

N/A – Non-forest vegetation indicated and the LTA is not rated.

Operability Limitations: This column lists the most limiting features to harvest by ground-base equipment.

Access – Road construction limitations severely limits access to the area.

Compaction – Soils have a thick or thin pure volcanic ash mantle that is highly susceptible to compaction.

Riparian – Area has a high potential for wet areas that will either limit access or season of use.

Slope – Areas within the map unit have slope gradients that exceed standard for ground-base equipment harvest.

Rutting/Compaction – Moderately fine and fine textured soils are highly susceptible to rutting and puddling when wet. These soils retain moisture well into the operating season and are also susceptible to compaction when moist.

Range Suitability – Cattle/Sheep: These columns list the degree of suitability for grazing management of cattle or sheep. The rating was determined based upon direction in 36 CFR 219.3 and Forest Service Manual (FSM) 1905. The following criteria was used to rate suitability for grazing: < 40% slope gradients for cattle and <60% slope gradients for sheep; < 50% rock outcrop; > 200 lbs/ac clipped dry wt. production, herbage production, and palatability. The first three criteria was used to determine range capability and the last two criteria were used to rate the degree in which the area was suitable for cattle grazing.

LOW (L) – The area is suitable for grazing; forage values is low. Either productivity is less than 500 lbs/acre and/or plant palatability is low to moderate.

MODERATE (M) – The area is suitable for grazing; forage values are moderate. Herbage production ranges from 500 – 1000 lbs/acre and palatability ranges from low to high.

HIGH (H) – The area is suitable for cattle grazing: forage values are high. Herbage production ranges from 500- >1000 lbs/acre and palatability is high.

UNSUITABLE (U) – The area is not capable of supporting cattle grazing. Slope steepness or rock outcrop exceeds standard; and/or forage values are very low with herbage productivity <200 lbs/acre or palatability is very low.

<u>Limitations to Range – Cattle/Sheep:</u> These columns list the most limit features to range suitability.

Forage – Forage value may be low, either by low herbage production or from low palatability, or both.

Riparian – Stream channels with riparian areas may be a major component of the area.

Seeps – Wet, boggy areas may occur within the LTA map unit.

Slope – A large amount of the area has slopes that exceed the FSM standard of >40% slope gradient for cattle and >60% slope gradient for sheep.

<u>Timber Suitability:</u> This column lists the rating for suitability of the LTA to support sustainable timber management. The ratings are based upon provisions in the Forest Management Act (NFMA 16 U.S.C 1604) that define unsuitable lands as those were technology is not available to ensure production without irreversible resource damage to soil or watershed conditions and/or there is no reasonable assurance that lands can be restocked following harvest.

LTA features that assist in predicting the potential to lead to one or both of these conclusions by carrying out timber management are: 1) removal of trees on landforms where tree removal and/or road construction has the potential for accelerated mass wasting or chronic soil erosion that can effect long term site productivity or water quality; 2) site productivity limits stand growth and sustainable timber management is not commercially viable; and 3) removal of trees in environments where site factors limit regeneration within 5 years. LTA features that have large areas with their map units unsuited for timber management are: steep Landform Groups such as Canyons and Glacial Trough Walls, Cirques, & Alpine Ridges with a high hazard for natural and management-related shallow rapid landslides and accelerated mass wasting; and Vegetation Zones – Parkland, Rock/Non-Vegetated and Dry or Moist Non-Forest which have soil and climatic factors that limit regeneration and forest productivity.

SUITABLE (S) – The area does not contain site factors where timber management using current best management practices and technologies would pose a potential hazard for irreversible resource damage to soil or watershed conditions. The forest has the potential to regenerate within 5 years given state-of-the-art silvicultural practices suited to site conditions are employed.

UNSUITABLE (U) – Inherent site factors pose a high hazard to irreversible resource damage to soil or watershed conditions or site productivity limits growth to a commercial product or regeneration can not be obtained within 5 years.

Limitations - Timber: This column lists the most limiting feature to timber management relative to the suitability definition referenced in the previous section.

Forest Productivity – Potential forest productivity is very low; <20 cubic feet/acre/year; e.g., shallow soils. These areas may not sustain a viable, commercial forest.

Regeneration – Regeneration is severely limited by site factors. Suitable timber management conditions are those where silvicultural practices can assist seedling establishment e.g., reduction of plant competition by scarification or burning; or provide shade using shelterwood prescriptions. Unsuitable management conditions are those where site factors are so severe that state-of-the art silvicultural practices are not successful in overcoming inherent site factors to assist seedling establishment.

Slope stability – Mass wasting and/or severe soil erosion processes may be accelerated by tree removal.

Road-Harvest Systems – Slope steepness limits road construction and harvest systems.

Table 13. Management Considerations – Suitability and Limitation to Forest Practices

LTA	Road Construct-ion	Road Limitations	Riparian (* stream along map unit edge)	Limitation to Harvest Operability	Limitations - Operability	Range Suitability Cattle	Limitations Cattle	Range Suitability Sheep	Limitations Sheep	Timber Suitability	Limitations - Timber
114	S-U	slope stability	Y	L	compaction	L	forage	L	forage	S	slope stability
115	S	drainage interception	Y	L	compaction	L	forage	L	forage	S	
116	S		N	L	compaction	L	forage	L	forage	S	
117	S		N	M	slope	L	forage, slope	L	forage	S	
118	U	slope stability, sediment delivery	Y*	H	slope, access	U	slope	U	slope	S	road-harvest systems
124	S-U	slope stability, clay soils	Y	M	rutting/ compaction	L	forage	L	forage	S	
125	S	drainage interception, clay soils	Y	M	rutting/ compaction	L	forage	L	forage	S	
126	S		N	M	rutting/ compaction	L	forage	L	forage	S	
127	S		N	M	slope, rutting/ compaction	L	forage, slope	L	forage	S	
131	S		Y	L	compaction	L	forage, riparian	L	forage, riparian	S-U	regeneration
132	U	slope stability, rock, sediment delivery	Y	H	slope, access	U	slope	L	forage, slope	U-S	regeneration, road-harvest systems
133	U-S	stream channel	Y	L		L	forage, riparian	L	forage, riparian	S	
135	S		Y	L		L	forage, riparian	L	forage, riparian	S	
144	S-U	slope stability	Y	M	rutting/ compaction	L	forage, seeps	L	forage, seeps	S	slope stability
146	S-U	slope stability	Y	M	rutting/ compaction	L	forage, seeps	L	forage, seeps	S	slope stability
155	S	drainage interception	Y	L	compaction	L	forage	L	forage	S	
156	S		N	L	compaction	L	forage	L	forage	S	
157	S		N	M	slope	L	forage, slope	L	forage	S	
158	U	slope stability, sediment delivery	Y*	H	slope, access	U	slope	U	slope	S	

Table 13. Management Considerations – Suitability and Limitation to Forest Practices (cont)

LTA	Road Construct-ion	Road Limitations	Riparian (* stream along map unit edge)	Limitation to Harvest Operability	Limitations - Operability	Range Suitability Cattle	Limitations Cattle	Range Suitability Sheep	Limitations Sheep	Timber Suitability	Limitations - Timber
165	S	drainage interception	Y	L	compaction	L	forage	L	forage	S	
166	S		N	L	compaction	L	forage	L	forage	S	
167	S		N	M	slope	L	forage, slope	L	forage	S	
168	U	slope stability, sediment delivery	Y*	H	slope, access	U	slope	U	slope	S	road-harvest systems
176	S		N	L		L	forage	L	forage	S	
177	S		N	M	slope	L	forage, slope	L	forage	S	
214	S-U	slope stability	Y	L	compaction	M	forage, seeps	M	forage, seeps	S	slope stability
215	S	drainage interception	Y	L	compaction	M	forage, riparian	M	forage, riparian	S	
216	S		N	L	compaction	M	forage	M	forage	S	
217	S		N	M	slope	L	forage, slope	M	forage	S	
218	U	slope stability, sediment delivery	Y*	H	slope, access	U	slope	U	slope	S	road-harvest systems
224	S-U	slope stability, clay soils	Y	M	rutting/ compaction	M	forage, seeps	M	forage, seeps	S	slope stability
226	S	clay soils	Y	M	rutting/ compaction	M	forage, seeps	M	forage, seeps	S	
227	S	clay soils, cutslope stability	N	M	slope, rutting/ compaction	L	forage, slope	M	forage	S	
231	S		Y	L	compaction	M	forage, riparian	M	forage, riparian	S	
232	U	slope stability, rock, sediment delivery	Y	H	slope, access	U	slope	L	slope	S-U	regeneration
233	U-S	stream channel	Y	L	riparian	M	forage, riparian	M	forage, riparian	S	
236	S		Y	L		M	forage, riparian	M	forage, riparian	S	

Table 13. Management Considerations – Suitability and Limitation to Forest Practices (cont)

LTA	Road Construct-ion	Road Limitations	Riparian (* stream along map unit edge)	Limitation to Harvest Operability	Limitations - Operability	Range Suitability Cattle	Limitations Cattle	Range Suitability Sheep	Limitations Sheep	Timber Suitability	Limitations - Timber
244	S-U	slope stability, clay soils	Y	M	rutting/ compaction	M	forage, seeps	M	forage, seeps	S	slope stability
246	S	clay soils	N	M	rutting/ compaction	M	forage	M	forage	S	
256	S		N	L	compaction	M	forage	M	forage	S	
257	S	cutslope stability	N	M	slope, compaction	L	forage, slope	M	forage	S	
258	U		Y*	H	slope, access	U	slope	U	slope	S	
265	S	cutslope stability	Y	L		M	forage, riparian	M	forage, riparian	S	
266	S		N	L		M	forage	M	forage	S	
267	S		N	M	slope	L	forage, slope	M	forage	S	
268	U	slope stability, sediment delivery	Y*	H	slope, access	U	slope	U	slope	S	road-harvest systems
273	U-S	stream channel	Y	L		M	riparian	M	riparian	S	
275	S		N	L		M	riparian	M	riparian	S	
276	S		N	L		M	forage	M	forage	S	
277	S		N	M	slope	L	slope	M	forage	S	
315	S		Y	N/A		H		H		U	forest productivity, regeneration
316	S		N	N/A		H		H		U	forest productivity, regeneration
317	S	cutslope stability	N	N/A		M	slope	H		U	
318	U	slope stability, sediment delivery	Y	N/A		U	slope	U	slope	U	forest productivity, regeneration
326	S	clay soils	N	N/A		H		H		U	forest productivity, regeneration

Table 13. Management Considerations – Suitability and Limitation to Forest Practices (cont)

LTA	Road Construct-ion	Road Limitations	Riparian (* stream along map unit edge)	Limitation to Harvest Operability	Limitations - Operability	Range Suitability Cattle	Limitations Cattle	Range Suitability Sheep	Limitations Sheep	Timber Suitability	Limitations - Timber
327	S	slope stability, clay soils	N	N/A		M	slope	H		U	forest productivity, regeneration
332	U		Y	N/A		H	riparian	H	riparian	U	forest productivity, regeneration
333	U-S	stream channel	Y	N/A		H	riparian	H	riparian	U	forest productivity, regeneration
356	S		N	N/A		H		H		U	forest productivity, regeneration
357	S	cutslope stability	N	N/A		M		H		U	forest productivity, regeneration
358	U	slope stability, sediment delivery	Y*	N/A		U	slope	U	slope	U	forest productivity, regeneration
365	S		Y	N/A		H	riparian	H	riparian	U	forest productivity, regeneration
366	S		N	N/A		H		H		U	forest productivity, regeneration
367	S		N	N/A		M	slope	H		U	forest productivity, regeneration
368	U	slope stability, sediment delivery	Y*	N/A		U	slope	U	slope	U	forest productivity, regeneration
376	S		N	N/A		H		H		U	forest productivity, regeneration
377	S		N	N/A		M	slope	H		U	forest productivity, regeneration
416	S		N	N/A		L		L		U	forest productivity, regeneration

Table 13. Management Considerations – Suitability and Limitation to Forest Practices (cont)

LTA	Road Construct-ion	Road Limitations	Riparian (* stream along map unit edge)	Limitation to Harvest Operability	Limitations - Operability	Range Suitability Cattle	Limitations Cattle	Range Suitability Sheep	Limitations Sheep	Timber Suitability	Limitations - Timber
418	U	slope stability, sediment delivery	N	N/A		U	slope	U	slope	U	forest productivity, regeneration
432	U	slope stability, rock, sediment delivery	Y	N/A		U	slope	U	slope	U	forest productivity, regeneration
433	U	wetlands	Y	N/A		L	riparian	L	riparian	U	forest productivity, regeneration
468	U	slope stability, sediment delivery	Y*	N/A		U	slope	U	slope	U	forest productivity, regeneration
518	U	slope stability, rock, sediment delivery	N	H		U	rock, slope	U	rock, slope	U	forest productivity, regeneration
532	U	slope stability, sock, sediment delivery	N	N/A		U	rock, slope, short season	L-M	rock, slope, short season	U	forest productivity, regeneration
558	U	slope stability, sock, sediment delivery	Y	H	slope, access	U	rock, slope	U	rock, slope	U	forest productivity, regeneration
567	U	rock		H	slope, access	U	rock, slope	L	rock, slope	U	forest productivity, regeneration
568	U	slope stability, rock, sediment delivery	Y*	H	slope, access	U	slope	U	slope	U	forest productivity, regeneration
736	S	cutslope stability	Y	H	slope, access	M	riparian	M	riparian	U	forest productivity, regeneration
832	U	rock, slope stability	N	N/A		U	slope	L-M	rock, slope, short season	U	forest productivity, regeneration

Natural Disturbance Regimes

Table 15 contains the Natural Disturbance Regimes for each Landtype Association. Listed below is a brief description of the information contained in each column of the table.

Hydrologic Event: Three *types* are identified as most likely to cause a channel response or flood. They are late fall/winter rain-on-snow; high intensity convective storms; and rapid spring snowmelt. These events do not occur in all Landtype Associations, they occur in some regions and not in others within the same Landtype Association, and the event can vary with elevation. Rain-on-snow is very uncommon and may not be easily distinguished from rapid snowmelt periods. High intensity convective storms occur during late spring and early summer and are very difficult to predict. They are local in extent covering one to several subwatersheds per event and are often generated by local or regional orographic effects. This table assumes the possibility of convective storms as a disturbing agent throughout the Blue Mountain ecoregion. A significant event can occur with rapid spring snowmelt, particularly when the ground is still frozen or when combined with spring rains.

Hydrologic Response: The table lists dominant geomorphic and hydrologic processes that are affected by the hydrologic event that can lead to a predicted channel response. Road drainage failures have been noted for those Landtype Associations where stream density is high or has a convergent pattern that accelerates runoff events.

Wind Event Response: The table lists an interpretation for potential response of mature forests to high wind events. Tree topple by wind is an important disturbance as it creates habitat features important to several wildlife species and effects movement of other species. The potential for wind topple influences selection of silvicultural practices and timber management programs. Frequency and location of wind disturbance may be higher in some locations due to orographic effects not predicted by the survey. This interpretation assumes the same potential for wind event across the landscape and a mature forest. The criteria used to develop the interpretation are: soil depth, bedrock hardness and resistance to root penetration, and topographic position of the LTA within the landscape setting. These relationships have been observed in the field during soil survey mapping in 1997 and 1998.

LOW – The LTA has deep soils and/or is located in a valley floor position which reduces the potential for tree topple from wind. Potential for stand level disturbance is low; isolated trees may fall but usually as a result of another initial disturbance agent, i.e., insect/disease.

MODERATE – The LTA has deep to moderately deep soils, is in a mid landscape position, and/or have hard, resistant bedrock. A severe windstorm could cause patches of trees to topple but the chance of stand-wide topple is low.

HIGH – The LTA has shallow to moderately deep soils, is on a summit or backslope position, and has hard, resistant bedrock or has tree species susceptible wind (engleman spruce) on seasonally wet soils. A severe windstorm may topple numerous trees in the

stand causing "jack-strawed" understories.

Variable – The LTA is variable and man conditions exist which may present a range of potential for wind topple.

n/a – The LTA is dominantly non-forest or has inclusions of open-grown forest and was not rated.

Fire Regime Disturbance (Historical): This column lists the numeric or alphanumeric code associated with historic fire regimes as defined by Lueschen (2000) in Fire Regimes of Oregon and Washington. This interpretation is limited to historical fire disturbance in an unmanaged setting. Fire regimes were applied to each LTA based upon the most dominant potential natural vegetation (PNV) or vegetation zone for the LTA. In some cases, PNV was combined with landform groups when terrain features uniquely influences distribution patterns of potential natural vegetation or frequency of fire. A table is provided below that describes fire frequency and severity and outlines the criteria for each fire regime code used in Lueschen (2000). In addition, this table includes a relative rating for each fire regime as it may affect vegetation communities either directly or indirectly.

It is widely accepted that most forest communities in the Interior Columbia Basin evolved and were maintained under various fire regimes. This interpretation is useful in comparing historical patterns of fire disturbance with today's existing or potential fire regimes given the additional information on existing vegetation structure or current fire incidence is known. According to research conducted from the Wenatchee Sciences Lab, historic fire regimes began to change approximately 100 years ago with the onset of forest management. Past management activities including grazing, vegetation manipulation, fire suppression have altered vegetation structure which can alter natural fire regimes (Everett, Schellhaas, Keenum, Spurbeck, and Ohlson [undated draft]). The effect of altered natural fire regimes is of concern to management and is currently being studied.

On the next page is a table illustrating the fire regime categories with an interpretation relating fire severity and frequency to degree of disturbance and response.

Table 14. Fire Regimes of Oregon and Washington (Lueschen 2000) and Relative Disturbance and Response in LTAs

Code	Frequency and Severity	Plant Communities and Fire Regime Description	Relative disturbance and response in LTAs
I	**0-35 years, Low Severity**	Typical potential plant communities include ponderosa pine, eastside/dry Douglas fir, pine-oak woodlands, Jeffery pine on serpentine soils, oak woodlands, and very dry white fir. Large stand-replacing fire can occur under certain weather conditions, but are rare events (i.e. every 200+ years).	VERY LOW – Low severity fire was likely a major contributor to nutrient cycling; converting forest floor to available nutrients. Frequent historic fire intervals kept fuels from accumulating that would have caused higher severity. Natural wood debris would have ranged from 5-15 tons/acre (Graham 1994). Forest floor duff layers ranged from non-existent to no more than one inch depth.
II	**0-35 years,**	Typical potential plant communities includes	LOW – Effects from natural fires were

Table 14. Fire Regimes of Oregon and Washington (Lueschen 2000) and Relative Disturbance and Response in LTAs

Code	Frequency and Severity	Plant Communities and Fire Regime Description	Relative disturbance and response in LTAs
	Stand-replacing, non-forest	true grasslands and savannahs with typical fire return intervals of less than 10 years; mesic sagebrush communities with typical fire return intervals of 25-35 years up to 50 years, and mountain shrub communities (e.g., bitterbrush, snowberry, ninebark, ceanothus, Oregon chaparral) with fire return intervals of 10-25 years. Fire severity is generally high to moderate; grasses and fire-tolerant shrubs are not completely killed and usually resprout.	probably low as most fires occurred in late summer when vegetation was semi-dormant from drought. Downed woody debris was localized and less than 5 tons/acre. Forest floor duff layers ranged from non-existent to over two inches in depth depending on fire frequency.
III	**35-100+ years, Mixed Severity**	This regime results in heterogeneous plant communities and includes several communities as described in subcategories "a-c" below. Large, stand-replacing fires may occur but are usually rare events. Such stand-replacing fires may "reset" large areas but subsequent mixed intensity fires are important for creating heterogeneity. Within this regime, stand structure and composition is not dominated by one or two age classes.	MODERATE – Effects from a range of non-lethal to lethal fire causes a diversity of disturbances. Downed woody debris would have been somewhat common and accumulations ranged from 10-15 tons/acre. Mixed severity fires causing some tree mortality would have contributed to cycling of down woody debris. Forest floor duff layers ranged from 0.5 to 1.0 inch depending on fire intervals. Thicker duff layers would have been maintained with lower frequency fire returns.
IIIa	**<50 years, Mixed Severity**	Typical potential plant communities include mixed conifer, very dry westside Douglas-fir, and dry grand fir. Lower severity fire tends to predominate in many events.	
IIIb	**50-100 years, Mixed Severity**	Typical potential plant communities include well drained western hemlock; warm, mesic grand fir, particularly east of the Cascade crest; and eastside western redcedar. The relative amount of lower and higher severity patches within a given event is intermediate between IIIa and IIIc.	
IIIc	**100-200 years, Mixed Severity**	Typical potential plant communities include western hemlock, Pacific silver fir, and whitebark pine at or below 45 degrees latitude and cool, mesic grand fir and Douglas-fir. Higher severity fire tends to dominate in many events.	
IV	**35-100+ years, Stand-replacing**	Typical potential plant communities are those where seral communities are maintained by stand replacing fires. Seral communities are comprised of Lodgepole pine, aspen, western larch, and western white pine. Dry sagebrush communities also fall within this fire regime. (Natural ignitions within this regime resulting in large fires may be relatively rare). This category is separated into subcategories having different potential climax plant communities.	HIGH – High severity fire is common with a variety of short term and long term effects to soils and forest structure. Highly variable patterns of age class and density is somewhat controlled by fire extent and regeneration response on different slope gradients and aspects. Downed woody debris would have been common and may have been extensive

Code	Frequency and Severity	Plant Communities and Fire Regime Description	Relative disturbance and response in LTAs
IVa	**35-100+ years, Stand-replacing, Juxtaposed**	Typical potential plant communities are located upslope from a plant community with a shorter fire regime interval. The community experiences a shorter fire interval that would be expected due to association with a plant community with a more frequent fire interval downslope. Examples include Lodgepole pine immediately above ponderosa pine in the eastside Washington Cascades and aspen imbedded within dry grand fir in the Blue Mountains. This regime is often found in lower elevations or drier sites than is considered typical for regime IV.	as a result of tree mortality. "Reburns' in areas of high debris accumulation would have reduced fuel levels and caused severe heating of soils and removal of duff layers. Down woody debris average range may have been 15-25 tons/acre (Graham 1994) or higher and forest floor duff layers ranged from 0.5 to 1.5 inches depending on severity and frequency.
IVb	**100+ years, Stand-replacing, Patchy arrangement**	Typical potential communities include subalpine fir and mountain hemlock parkland and whitebark pine north of 45 degrees latitude.	
IVc	**100-200 years, Stand-replacing**	Typical forest communities include subalpine mixed conifer (e.g., spruce-fir), western larch, and western white pine. Important potential plant communities include mountain hemlock in the Cascades and Pacific silver fir north of 45 degrees latitude.	
V	**>200 years, Stand-replacing**	This fire regime occurs at the environmental extremes where natural ignitions are very rare or virtually non-existent or environmental conditions rarely result in large fires. Sites tend to be very cold, very hot, very wet, very dry or some combination of these conditions.	VERY HIGH – High severity fire in plant communities less adapted to fire disturbance. Downed woody debris would have been abundant and often exceeded 30 tons/acre (Graham 1994). Coarse woody debris would have substantially contributed to biomass of forest floor duff layers. Duff layers often exceeded 2 inches and were composed of approximately 50 percent decaying wood. After fire, these characteristics would be reset.
Va	**200-400 years, Stand-replacing**	Plant communities are somewhat fire adapted. Typical communities include Douglas-fir, noble fir, and mountain hemlock on drier sites in western Washington.	
Vb	**400_ years, Stand-replacing**	Plant communities are less fire adapted. Typical plant communities include Douglas-fir, Pacific silver fir, western hemlock western redcedar, and mountain hemlock on moister sites in western Washington.	
Vc	**No Fire**	Plant communities have no evidence of fire for 500+ years. Typical plant communities include Sitka spruce, Pacific silver fir and very wet western redcedar sites.	NONE – Natural fire of any extent is uncommon.
Vd	**Non-forest**	Typical plant communities include black sagebrush, salt desert scrub, alpine communities, and subalpine heath. Most species tend to be small and low growing. Bare ground is common.	

Table 15. Natural Disturbance Regimes and Responses

LTA	Hydrologic_Event	Hydrologic_Response	Wind Event_Response	Fire Regime	Resonse to Fire
114	High stream flows	Stream erosion along margins initiates landslide	Variable	IIIb, IIIc, IV	Moderate-High
115	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	Moderate	IIIb, IV	Moderate-High
116	Convective Storm/Rapid Snowmelt	Overland flow and ponding	High	IIIb, IV	Moderate-High
117	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	Moderate	IIIb, IV	Moderate-High
118	Convective Storm/Rapid Snowmelt	Shallow rapid landslides	Moderate	IIIb, IVa	Moderate-High
124	High stream flows	Stream erosion along margins initiates landslide	Variable	IIIb	Moderate
125	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	Moderate	IIIb	Moderate
126	Convective Storm/Rapid Snowmelt	Overland flow and ponding	Moderate	IIIb	Moderate
127	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	Moderate	IIIb	Moderate
131	Rapid Snowmelt/High stream flows	Stream channel migration	Moderate-High	IIIc, Ivc	Moderate-High
132	Convective Storm/Rapid Snowmelt	Shallow rapid landslides, snow avalanche	Variable	IVc	High
133	High stream flows	Stream channel migration	Low	IVc	High
135	Convective Storm/Rapid Snowmelt	Colluvial stream scour/fan deposition; road drainage failures	Low	IVc	High
144	Convective Storm/Rapid Snowmelt	Stream at margin undercuts slope or groundwater initiates landslide	Variable	IIIb, IIIc, IV	Moderate-High
146	Convective Storm/Rapid Snowmelt	Overland flow and ponding; landslide	Low	IIIb, IIIc, IV	Moderate-High
155	Convective Storm/Rapid Snowmelt	Colluvial stream scour/fan deposition; road drainage failures	Moderate	IV	High
156	Convective Storm/Rapid Snowmelt	Overland flow	Moderate	IV	High

Table 15. Natural Disturbance Regimes and Responses (cont)

LTA	Hydrologic_Event	Hydrologic_Response	Wind Event_Response	Fire Regime	Resonse to Fire
157	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	Moderate	IV	High
158	Convective Storm/Rapid Snowmelt	Shallow rapid landslides	Moderate	IIIb, IV	Moderate-High
165	Convective Storm/Rapid Snowmelt	Colluvial stream scour/fan deposition; road drainage failures	Moderate	IV	High
166	Convective Storm/Rapid Snowmelt	Overland flow	Moderate	IIIb, IV	Moderate-High
167	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	Moderate	IIIb, IV	Moderate-High
168	Convective Storm/Rapid Snowmelt	Shallow rapid landslides	Moderate	IIIb, IV	Moderate-High
176	Convective Storm/Rapid Snowmelt	Overland flow	Moderate-High	III, IV	Moderate-High
177	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	Moderate	III, IV	Moderate-High
214	High stream flows	Stream erosion along margins initiates landslide	Variable	III	Moderate
215	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	Moderate	III	Moderate
216	Convective Storm/Rapid Snowmelt	Overland flow and ponding	High	III	Moderate
217	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	Moderate	III	Moderate
218	Convective Storm/Rapid Snowmelt	Shallow rapid landslides,accelerated erosion	Moderate	III	Moderate
224	High stream flows	Stream erosion along margins initiates landslide	Variable	III	Moderate
226	Convective Storm/Rapid Snowmelt	Overland flow and ponding; gully erosion	Moderate	III	Moderate
227	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	Moderate	III	Moderate
231	Rapid Snowmelt	Stream channel migration	Moderate	IIIc	Moderate

Table 15. Natural Disturbance Regimes and Responses (cont)

LTA	Hydrologic_Event	Hydrologic_Response	Wind Event_Response	Fire Regime	Resonse to Fire
232	Convective Storm/Rapid Snowmelt	Shallow rapid landslides, snow avalanche	Moderate	III	Moderate
233	High stream flows	Stream channel migration	Low	IIIc	Moderate
236	Convective Storm/Rapid Snowmelt	Overland flow	Low	IIIc	Moderate
244	Convective Storm/Rapid Snowmelt	Stream erosion along margins or groundwater initiates landslide	Variable	III	Moderate
246	Convective Storm/Rapid Snowmelt	Overland flow and ponding; landslide	Low	III	Moderate
256	Convective Storm/Rapid Snowmelt	Overland flow and ponding	Moderate	III	Moderate
257	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	Moderate	III	Moderate
258	Convective Storm/Rapid Snowmelt	Shallow rapid landslides, accelerated erosion	Moderate	III	Moderate
265	Convective Storm/Rapid Snowmelt	Colluvial stream scour/fan deposition; road drainage failures	Low	III	Moderate
266	Convective Storm/Rapid Snowmelt	Overland flow and ponding	Moderate	III	Moderate
267	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	Moderate	III	Moderate
268	Convective Storm/Rapid Snowmelt	Shallow rapid landslides	Moderate	III	Moderate
273	High stream flows	Stream channel migration	Low	IIIc	Moderate
275	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	Low	III	Moderate
276	Convective Storm/Rapid Snowmelt	Overland flow	Moderate	III	Moderate
277	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	Moderate	III	Moderate
315	Convective Storm/Rapid Snowmelt	Colluvial stream scour/fan deposition; road drainage failures	n/a	I, II	Very Low-Low

Table 15. Natural Disturbance Regimes and Responses (cont)

LTA	Hydrologic_Event	Hydrologic_Response	Wind Event_Response	Fire Regime	Resonse to Fire
316	Convective Storm/Rapid Snowmelt	Overland flow	n/a	I, II	Very Low-Low
317	Convective Storm/Rapid Snowmelt	Overland flow	n/a	I, II	Very Low-Low
318	Convective Storm/Rapid Snowmelt	Shallow rapid landslides, accelerated erosion	n/a	I, II	Very Low-Low
326	Convective Storm/Rapid Snowmelt	Overland flow and ponding	n/a	I, II	Very Low-Low
327	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	n/a	I, II	Very Low-Low
332	Convective Storm/Rapid Snowmelt	Shallow rapid landslides, snow avalanche, accelerated erosion	n/a	V, Vd	Very High
333	High stream flows	Stream channel migration	n/a	I, II	Very Low-Low
356	Convective Storm/Rapid Snowmelt	Overland flow	n/a	I, II	Very Low-Low
357	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	n/a	I, II	Very Low-Low
358	Convective Storm/Rapid Snowmelt	Shallow rapid landslides, accelerated erosion	n/a	I, II	Very Low-Low
365	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	n/a	I, II	Very Low-Low
366	Convective Storm/Rapid Snowmelt	Overland flow	n/a	I, II	Very Low-Low
367	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	n/a	I, II	Very Low-Low
368	Convective Storm/Rapid Snowmelt	Shallow rapid landslides, accelerated erosion	n/a	I, II	Very Low-Low
376	Convective Storm/Rapid Snowmelt	Overland flow	n/a	I, II	Very Low-Low
377	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	n/a	I, II	Very Low-Low
416	Convective Storm/Rapid Snowmelt	Overland flow	n/a	I, II	Very Low-Low

Table 15. Natural Disturbance Regimes and Responses (cont)

LTA	Hydrologic_Event	Hydrologic_Response	Wind Event_Response	Fire Regime	Resonse to Fire
418	Convective Storm/Rapid Snowmelt	Shallow rapid landslides	n/a	I, II	Very Low-Low
432	Convective Storm/Rapid Snowmelt	Shallow rapid landslides, snow avalanche	n/a	I, II	Very Low-Low
433	High stream flows	Stream channel migration	n/a	I, II	Very Low-Low
468	Convective Storm/Rapid Snowmelt	Shallow rapid landslides	n/a	I, II	Very Low-Low
518	Convective Storm/Rapid Snowmelt	Shallow rapid landslides	n/a	V, Iva	High-Very High
532	Convective Storm/Rapid Snowmelt	Shallow rapid landslides, snow avalanche	n/a	V, Iva	High-Very High
558	Convective Storm/Rapid Snowmelt	Shallow rapid landslides	n/a	V, Iva	High-Very High
567	Convective Storm/Rapid Snowmelt	Accelerated erosion	n/a	V, Iva	High-Very High
568	Convective Storm/Rapid Snowmelt	Accelerated erosion	n/a	V, Iva	High-Very High
736	Convective Storm/Rapid Snowmelt	Colluvial stream downcutting; road drainage failures	n/a	I, III	Very Low - Moderate
832	Convective Storm/Rapid Snowmelt	Shallow rapid landslides, snow avalanche, accelerated erosion	n/a	Ivb	High

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